THE

ELECTRICAL REVIEW.

VOL. XXX. APRIL 8, 1892. No. 750

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RADIATION OF HEAT FROM THE SURFACE OF DYNAMO MACHINES.

UNDER the above title there has recently appeared in the columns of our contemporary, *L'Electricien*, an interesting article by M. Rechniewski, which gives details of some tests carried out by him to determine the amount of cooling surface that must be provided in any armature, so that its surface temperature shall not exceed that of the surrounding air by more than a fixed number of degrees. The article commences by pointing out the great importance of this question of the rise of temperature, since in most machines it is the heating of the armature that practically limits the output; and it says that it is surprising that none of the dynamo builders who must of necessity have made a study of this subject should have published any work, giving, for instance, the number of square centimetres of cooling surface which must be provided per watt transformed into heat. As, however, the next paragraph tells us that the amount of surface required per watt is very variable, being dependent on the geometric form and the nature of the surface, any figures which can be given must be only approximate, and must be applied with considerable caution, if they are to be used for other machines than those from which they were obtained; and it is probably this difficulty that has deterred many engineers from publishing the results of tests, which, though useful when applied to similar armatures, might be very misleading if applied to armatures of other types.

We would, however, remind our readers that approximate figures have been published before now, notably by Mr. Kapp and Mr. Esson, and we have no doubt that they have often been found useful. Mr. Kapp's rule, which he published in 1886, allowed from ·8 to 1 square inch (say, 5·2 to 6·5 square centimetres) per watt transformed into heat in an armature with a peripheral speed of 2,000 to 3,000 feet per minute, if it was so constructed as to allow of fair ventilation and was run in a cool room; and from 1·5 to 2 square inches (say, 9·7 to 13 square centimetres) for badly ventilated armatures run in a hot place, such as is often provided on board ship. Mr. Esson, in his paper on "Dynamo Design," read at the Institution of Electrical Engineers some two years ago, also discussed the question of heating, and gave formulæ for the relation between cooling surface per watt and the permissible rise of temperature, which showed that for a ring armature of usual proportions run at a peripheral speed of about 3,000 feet per minute, the surface to be provided per watt should be about $\frac{225}{C}$ square centimetres, where C is the permissible rise of temperature in degrees Centigrade. When speaking of this permissible rise of temperature, M. Rechniewski says that some specifications do not permit a greater rise than 30° Cent.; but this, he considers, is asking too much, as a rise of 50° Cent., which is often specified, is quite permissible, and will not damage the

insulation. Of course, the permissible rise must depend on the temperature of the surrounding air, but, in any case, we think that 50° Cent. is a high figure to take, since it refers only to the surface temperature, which may be a good deal lower than that attained by the part of the winding which is inside next the iron core. In England, the figure most frequently met with in specifications is about 30° Cent., which seems to us a very fair allowance for ordinary working conditions in a properly ventilated dynamo room, but in some cases a much lower figure is specified, notably, by the Admiralty, who only allow a rise of 30° Fahr., or, say, 17° Cent.

Turning, now, to the actual tests, we find that results are obtained varying from 7·5 to 3·3 square centimetres per watt for a rise of 50° Cent., the armatures tested being of the types and diameter shown in the accompanying table, which gives a summary of the results :—

Type of armature.	Outside diameter in centimetres.	Revolutions per minute.	Square centimetres per watt.
Drum	12	1,656	7·14
„	17·5	850	6·90
„	27	590	7·50
„ (ventilated) ...	27	960	4·25
Manchester	36	1,000	5·73
8-pole ring...	50	690	3·30
„	50	490	3·56
„	50	500	3·51

From these figures M. Rechniewski concludes that the large central opening in the armature of the multipolar machine gives that type a considerable advantage over the 2-pole ring or ventilated drum armatures, and that in like manner the latter is much better than the drum armature with no central opening. In this matter of the importance of ventilation, we suppose that all engineers are of one opinion, as the designs of most of our leading dynamo makers have been modified during the last two or three years in such a manner as to take advantage of the increased output which can be obtained by providing means for ventilation of the armature. A second deduction made from these figures is, that the peripheral speed of the surface, within the limits embraced by these experiments, has but a very small effect on the value of the cooling surface ; but respecting this, as also the statement made by M. Rechniewski that the losses due to eddy currents are so small that they may be neglected, we believe that many engineers are of a different opinion.

In both the rules for cooling surface quoted above, it will be noted that restrictions are placed on the speeds for which they are applicable, and more recently Mr. Esson, when replying to the discussion on his paper on "The Design of Multipolar Dynamos," gave a formula for smooth armatures in which the peripheral velocity appears as a factor, viz., $s = \frac{55\ w}{c\ (1 + \cdot00018\ v)}$ where s is the surface in square inches, w the energy in watts, c the rise of temperature in degrees Centigrade, and v the peripheral velocity in feet per minute. Such a relation does not appear to be inconsistent with the figures quoted by M. Rechniewski, as it will be observed that the best surface efficiencies were obtained by him with the higher peripheral velocities ; and this would have been still more marked, but for the fact that the eddy current losses are not taken into account in calculating the energy expended in heating the armature, as these losses vary as the square of frequency, and this latter ranges from 32 to 46 for the multipolar machine tests, and is 16 for the ventilated drum armature against 10 for the drum of similar dimensions, but without a central opening.

With regard to the relative importance of eddy current losses and hysteresis losses, Mr. Housman stated, when describing his graphic method of separating them, that he had generally found the eddy current loss to be the larger of the two ; and Mr. Mordey, in his paper on "Alternate Current Working," showed that in the Victoria continuous current dynamo the eddy current losses were by no means negligible, the actual figures reduced to watts per cubic centimetre of iron being $\cdot00096n$ watts due to hysteresis, and $\cdot000093n^2$ watts due to eddy currents, which shows that the losses would be about equal at a frequency of 10 ∿. Of course, one expects a greater eddy current loss in an armature like the Victoria, where the lines of force enter the ring both radially and from both sides ; but at the same time it must be noted that the induction was only 12,300 C.G.S. units, whilst in the machines tested by M. Rechniewski it was 17,000, except in the 8-pole machine, in which it was only 10,000, but at a much greater frequency ; and the higher induction in the one case, and the greater frequency in the other, would go a long way towards counterbalancing any advantage gained by the laminations of the iron being more favourably placed.

We consider that the neglect of the eddy current losses reduces very much the value of the results obtained, and should like to see a similar series of tests on heating made in conjunction with other tests for separating the hysteresis and eddy current losses, as there would then be no need to calculate the watts expended in heating the iron core on insufficient or uncertain data, and the results would be of greater practical value to all those concerned in the manufacture or use of dynamo machines.

THE MANUFACTURE AND INDUSTRIAL VALUE OF ALUMINIUM.

An important paper by Mr. J. H. J. Dagger, F.I.C., F.C.S., dealing with the manufacture and industrial value of aluminium, has recently engaged the attention of the Liverpool section of the Society of Chemical Industry. This is a subject upon which Mr. Dagger is entitled to be heard. Many will remember the excellent account given by this gentleman before the same society in May last year, of the now well-known electrolytic method for the production of aluminium. The processes then noticed were the "Herault," as carried on at the works of the Aluminium Industry Company, Limited, Neuhausen, and those of the Société Electrometallurgique, at Froges, near Grenoble, and the "Hall" process of the Pittsburg Reduction Company, U.S.A. These methods are typical of the most recent advance in the metallurgy of aluminium, and Mr. Dagger is of opinion that no departure will be made from the main outline of these processes in the present state of our knowledge of the conditions of the reduction of aluminium from its combinations, for some time to come.

In the "Herault" and "Hall" processes, and in the electrolytic process carried on at the works of the Cowles Company, Lockport, U.S.A., the conditions are essentially the same, the electrolysis of alumina dissolved in a bath of fused haloids, salts of aluminium, and metals of the alkalies, and alkaline earths, preferably the fluorides.

In the process described by Mons. Minet in the *Comptes Rendus*, February 17th, June 9th, 1889, and October 27th, 1890, the bath is composed of a mixture of chloride of sodium, and the double fluoride of aluminium and sodium, as expressed by the formula :—

$$\underbrace{6\,Na\,Cl}_{348} + \underbrace{Al\,F_3, 3\,Na\,F}_{210}$$

or	Na Cl	62·5
	3 Na F. Al F_3 ...	37·5
		100·0

Such a mixture melts at 675° C. The composition of the bath is maintained constant during the operation by means of the following mixture :—

		Per cent.
Hydrate of alumina (partly dried) ...	6 (Al_2O_3, 2 H_2O) ... 416·4 =	48·2
Double fluoride of aluminium and sodium	Al_2F_6 . 6 Na F .... 210·4 =	24·3
Oxyfluoride of aluminium	Al_2F_6 . 3 Al_2O_3 ... 238·4 =	27·5
		100·0

This mode of alimentation enables the two-thirds of the fluorine given off at the positive pole to be replaced. The bath is kept at the same level by the introduction of a mixture of chloride of sodium and double fluoride of aluminium and sodium in the proportion before given.

It may be observed that in this process it is the fluoride that is electrolysed, in the other processes it is the alumina that undergoes decomposition, the loss in the bath itself being only very slight, provided care is taken not to let the pots get "out of ore" (alumina), this being shown by the increased resistance indicated by the voltameter. Should, however, this be neglected, the current begins to act upon the materials of the bath, the halogen of the salts used being given off instead of the carbon monoxide produced under normal conditions.

Mons. Minet claims that by his method he attains the production of 32 grammes of aluminium for 1 H.P. hour with E.M.F. of 4 volts, and the return of electric energy as 70 per cent. Mr. Dagger, however, has unfortunately been unable to procure further information as to this process or to verify the results obtained.

But Mons. Minet's papers in the *Comptes Rendus* are well worth perusing together, if our readers have not done so already, as he goes into the theory of the decomposition of fixed aluminium fluoride, and tabulates the results he obtained under varying conditions of current and temperature.

From his own experience and knowledge Mr. Dagger, however, considers that the use of more easily decomposing mixtures than those of the fluorides, even the addition of chloride of calcium, as is sometimes advocated, is attended with practical difficulties, and requires much greater skill and intelligence than could be well expected from workmen. And therefore at present the simpler methods of the three great companies will continue to supply the greatest part of the aluminium required, and any further development will lie rather in the cheapening of the methods of preparing alumina, and improvements in the construction of dynamos, and the application of steam ; above all, water-power.

Mr. Dagger then turned to the chemical and physical properties of aluminium. He quoted Le Chatelier's statistics on the influence of temperature on the tensile strength of this metal, and gave the results of a number of tests of tensile strength and elongation which have been made at Lockport and by the Neuhausen Company. These figures showed fairly the mechanical value of aluminium, and from these it is evident, as has been stated before, that this new metal can never take the place of steel and iron for structural purposes, such as bridges and heavy machinery ; it is not a rigid metal, and its elasticity is low ; though it is one-third the weight of iron, it has one-half the tensile strength of the best wrought iron, and one-third that of mild steel. But it is the lightest of all industrial metals, and this lightness is combined with a tensile strength not far below gun-metal when it is rolled or drawn, and equal to cast-iron in castings. It is an excellent conductor of electricity ; its melting point, 700° C., is between that of zinc, 433° C., and copper, 1,082° C., its high specific heat rendering it the most valuable of all metals for fine castings and light machine work, and its corrosion resistance is only inferior to that of the noble metals. Aluminium, surely, with these properties, needs no special pleading.

Not the least interesting part of Mr. Dagger's lengthy paper is that in which he described corrosion experiments with aluminium. These, however, are in detail, of more particular interest to those who possess a chemical bias, and such we must refer to the original paper. This question of corrosion is obviously of the greatest importance, because it will determine the limits of the use of aluminium.

As we have already hinted, Mr. Dagger is peculiarly entitled to be heard concerning aluminium, and hence, at the risk of repetition, we will enumerate some of the uses to which the properties of the new metal, in his opinion, appear to point. It will replace copper and brass for kitchen utensils, not only because it resists corrosion, but because, in the event of any taking place, the salts formed are not poisonous ; an aluminium saucepan would, while possessing the same strength, be three and a-half times lighter than those now in common use. The slow cooling of aluminium will suggest many uses in connection with culinary and other matters. Aluminium ware, whilst stiffer, lighter, and harder than tin-ware looks much nicer, hence all articles now made of tinned iron may be replaced by it. It can replace many laboratory utensils now made of copper or galvanised iron. Flasks and water-bottles of all kinds, more especially for military service, would be advantageously made of aluminium, as they would not only be unbreakable, but be lighter than the glass and enamelled iron. Its indifference to organic acids would suggest its use for brewers, vintners, and licensed victuallers. Cups, flasks, &c., might be made of it, and then silvered, though the metal itself has a good appearance, and will not tarnish as silver does. For scientific instruments of all kinds, especially frames and tubes of surveying and astronomical apparatus, for chemical balances and all metal work exposed to no strain above the limits of its tensile strength, aluminium, by virtue of its lightness, would be invaluable.

C

Scales for measuring and indicater scales of this metal, would not warp or crack, as do those of ivory or wood when exposed to a damp atmosphere. Its utility for tubes has been demonstrated by the Mannesman Company. For gas and light fittings—chandeliers, candelabra, lamps, &c.—its appearance and lightness will commend it; but the engineer and craftsman will readily think of a much wider scope for aluminium than is indicated in these suggestions.

Mr. Dagger did not touch upon the value of aluminium in alloys; that was well done in his paper before the British Association in 1889, and in a paper dealing with their mechanical properties as a material for artillery, read before the Mechanical section of the British Association in 1890.

In conclusion, we may note that a recent issue of the *Bulletin de Musée Commerciale* gives the following statistics regarding the present production of aluminium.

	lbs. per diem.
The Neuhausen Works	1,000
The Pittsburg Reduction Company ...	600
The Metal Reduction Syndicate, Limited	300
The Cowles Company	600-700 in alloys

The present production of aluminium of the world per diem may be taken at about 3,000 lbs., for there is reason to believe that the above figures are somewhat understated.

TESTS OF ELECTRIC RAILWAY POWER PLANTS.

In a paper read by Mr. C. W. Wason before the Cleveland Electric Club, some figures are given relating to electric traction, which should be of interest at the present moment whilst Mr. Reckenzaun's paper at the Institution is under discussion. Mr. Wason gives the results of a comparative test of high and low speed engines, driving dynamos supplying current to an electric railway, the high speed engines being of the Armington & Sims type, each belted direct to two Edison dynamos, of which six were of 40, and six of 80 kilowatts capacity, whilst the low speed engines were simple Corliss engines, two in number, belted through a common countershaft to four Edison dynamos of 175 kilowatts each. The tests lasted for 10 hours in each case, during which time the amount of coal and water consumed was measured, electrical readings were taken every 15 seconds at the station, and an account was kept of the number of motor and tow cars on the line, and of the mileage of each. The results of the tests were as follows:—With high speed engines, and 71 motor cars and 11 tow cars, making during the ten hours a total car mileage of 5,617, the average electrical horse-power developed was 563, or 6·86 per car, the coal consumption (a bituminous slack coal was used which left about 13 per cent. of ash) was 6·55 lbs. per electrical H.P. per hour, or 6·57 lbs. per car mile, and the water consumption 43·29 lbs. per electrical H.P. per hour; with low speed engines, and 71 motor cars and 12 tow cars making during ten hours 5,682 car miles, the average electrical H.P. developed was 630, or 7·59 per car, the coal consumption was 5·76 lbs. per electrical H.P. per hour, or 6·38 per car mile, and the water consumption 37·69 lbs. per electrical H.P. per hour. As accounting for some of the considerable difference on the two days in the horse-power per car, it may be noticed that during the first test it was rainy, and during the second foggy, and that on the latter day about 25 per cent. more passengers were carried, which would probably increase the number of stops and starts, and so add considerably to the energy required to propel the car. In both cases the results as regards coal and water consumption seem very good, those obtained with the Corliss engines being about equal to the best results named by Mr. Reckenzaun.

Power Transmission and Oil Insulation.

Professor Elihu Thomson has been advocating the transmission of 130,000 horse-power a distance of 240 miles at 500,000 volts through three wires about as large as a knitting needle, using oil insulation in a pipe for the purpose. As Mr. Swinburne pointed out in the recent discussion on Prof. Hughes's paper on oil insulation, the latter is all very well under certain conditions; but when the high voltage has horse-power behind it the result when a spark strikes across the oil will be very different from the case of a high voltage derived from a Wimshurst machine. The result of the Ferranti system in connection with the London Electric Supply Corporation is not such as to give encouragement to the idea of working at the tension advocated.

The London Electric Supply Corporation.

The unsatisfactory position in which this company stands at present is indicated by the somewhat faint praise which is now bestowed upon it by some of its former strongest advocates. It is true that the reports of the managers of the company are expressed in terms full of hope, but they are not terms of confidence. Some ill luck has no doubt hampered the operations; accidents will happen in the best regulated undertaking, but far more of the unsatisfactory results are due to the whole concern being of the nature of a huge and costly experiment carried out by an enthusiast of limited experience. There is a great deal of talk about "defect after defect being eliminated," and "failure is not found to re-occur," and there being "no reason to doubt that high-pressure electricity has at last been brought under control." If the whole question were not limited by the question of finance the system could, doubtless, eventually be made a success, in the sense, for example, that the proposed 10,000 horse-power plant, after being built and rebuilt and the mains relaid, could be made to deliver its electrical supply as intended; but people do not invest their capital for the sake of seeing an engineering success only. The example of Mr. I. K. Brunel in the past appears to have been forgotten; the genius of that gentleman evolved the broad gauge, the Thames Tunnel, the *Great Eastern*, &c., all of which were great engineering successes but equally big commercial failures. We find it stated (see the *Engineer*) that "the Deptford staff now possess a practical knowledge of the working of 10,000 volts current, of a kind possessed by no other engineers in the world. The knowledge acquired will bear fruit as long as electricity is generated by dynamos and transmitted over cables." Quite true, but not in the sense intended by our contemporary.

THE TESLA MULTIPHASE CURRENT MOTORS.*

By ALBERT SCHMID.

The prominence which has been given to power transmission by multiphase currents in the experiments between Frankfort and Lauffen, seems to have led to the impression, even among those otherwise well-informed, that this was the first example of this method of transmission. It may therefore be well to put on record the fact that in this country multiphase motors manufactured by the Westinghouse Company have been in successful commercial operation for several years, and a three-phase power plant has been in daily service in the shops of the Westinghouse Company at Pittsburgh for some time past, driving the shafting and machinery of the winding department.

As is well known, Mr. Nikola Tesla is the inventor of the multiphase motor, and his patents in this country are controlled by the Westinghouse Electric and Manufacturing Company, who have been quietly standardising the different sizes and have, within the last year or two, placed a large number of them in service.

The generators for these motors are of the Westinghouse multipolar type, with toothed drum armatures wound to give currents of 60 or 90 degrees difference of phase. These machines are built either entirely self-exciting and self-regulating, or separately exciting and self-regulating. The machine shown is designed for 60 kilowatt capacity.

The motors are constructed with internal poles and grooved armatures. The larger motors have armatures with three collecting rings, and the fields are excited with direct current. The smaller ones have armatures wound with coils closed upon themselves, doing away with all collecting rings and commutators. The engraving, fig. 2, shows a 10 H.P. Tesla motor and fig. 3 exhibits the armature removed from the enclosing field magnets. These multiphase motors are built in sizes of from 1 to 1,000 H.P.

A 1,000 H.P. three-phase generator or motor, for the same machine can be made either as a motor or generator, is shown in the engraving fig. 1, and when run as a generator will give 150 ampères at 5,000 volts. In mechanical design this machine is similar to the multipolar direct current railway generators built by the Westinghouse Company. The armature is of the drum type with slots for the wire and is without bands.

With the Tesla multiphase system the power can be subdivided to any extent for motor or lighting purposes, and high pressures may be employed which can be reduced to whatever voltage is desired. The multiphase motors start under load, and run at constant speed. The smaller ones are made entirely alternating, and the larger ones are self-exciting after reaching synchronism.

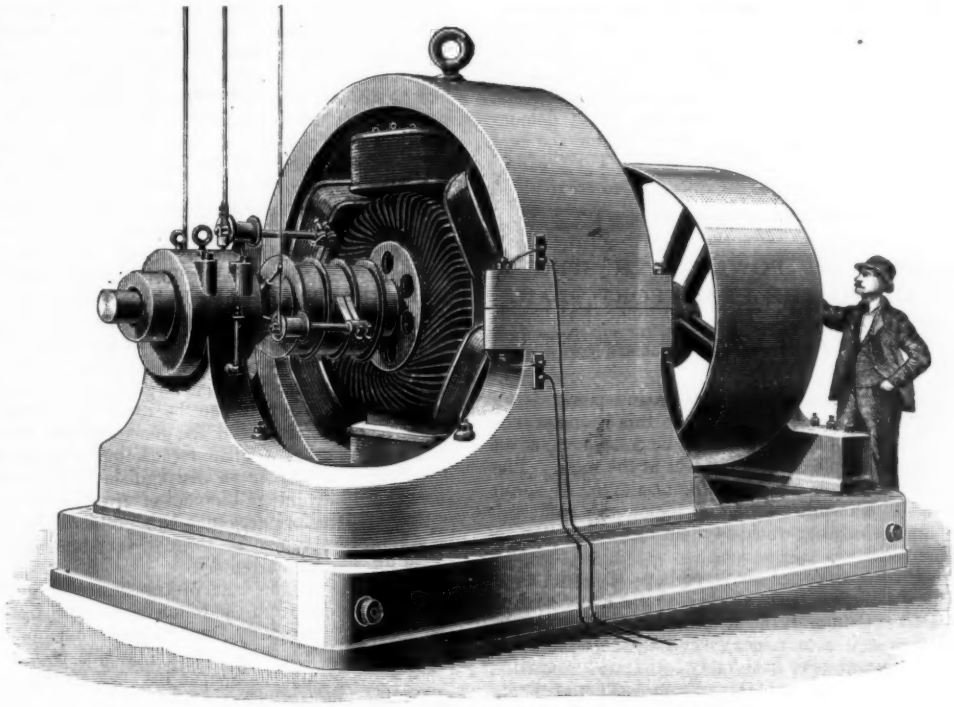
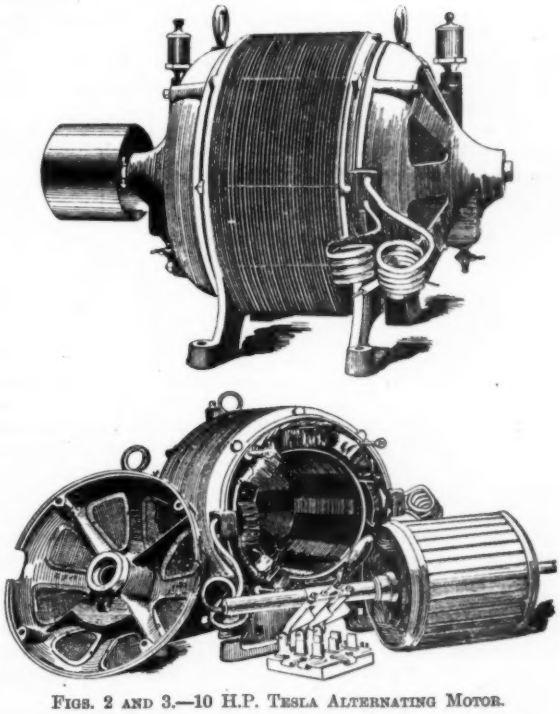


Fig. 1.—Three-Phase 1,000 H.P. Tesla Alternating Motor.



Figs. 2 and 3.—10 H.P. Tesla Alternating Motor.

As the starting torque with the Tesla multiphase motors is comparable with shunt wound direct current machines, they may be applied in every case where direct current

* *Electrical Engineer*, New York.

shunt wound motors can be used. At starting, the direct current motors require dead resistance in series, which means considerable loss, but the alternating current motor has inductive resistance, and therefore the loss at starting is much less. Multiphase motors can be used for operating mines, factories, and street railways, and the generating station may be located wherever most convenient for obtaining the best results, and if the pressure is not over 5,000 volts, the motors may be supplied direct from the mains. The Tesla motor has a great advantage over other types of motors in that it requires no commutator, and consequently is sparkless. The motor may be boxed up, and kept free from dust and grit, and high pressures can be employed successfully. No starting resistance is required and the motor is small and compact, and requires no attention. Tests made at the Westinghouse Company's works demonstrate that the Tesla motors are fully as efficient as the best direct current motors.

TRANSMISSION OF POWER WITH SPECIAL REFERENCE TO THE FRANKFORT PLAN.*

By CARL HERING.

The most prominent method of transmitting power is by means of shafts and belts, but although this is one of the best for very short distances, it need not be considered at all for anything over a couple of hundred feet at the most. The fact that it takes a 2-inch rope, running at a speed of 2,000 feet per minute, to transmit only 36 horse-power, is sufficient to show the impracticability of this system for long distances or large powers.

Transmission by compressed air is, perhaps, the chief rival of electrical transmission, with which it shares many advantages over all the others. It is at present used chiefly in mines, where it is still a very successful rival of electricity, but from present appearances it is likely that it will gradually be replaced by the latter method. From a paper of Prof. Unwin, it appears that the transmission of power by compressed air is practicable to a distance of at least 20 miles. It seems that 10,000 H.P. can be transmitted to a distance of 20 miles in a 30-inch main at 132·3 lbs. per square inch pressure, with a loss of pressure of only 12 per cent. The efficiency of such a plant is said to be 40 to 50 per cent., if the air is used cold, and 59 per cent. to 73 per cent. if the air is re-heated.

A very good idea of the relative efficiencies of several of these systems may be obtained from the following table by Beringer, giving the efficiencies for different distances.

Efficiency in per cent.

Distance in miles.	Hydraulic.	Pneumatic.	Wire rope.
½	50	55	91
1	49	54	85
3	41	51	61
5	37	50	43
10	26	43	21
13	18	39	11

Coming now to electrical transmission, long experience and frequent attempts have shown that it is not practicable to exceed 5,000 or 6,000 volts at the very most on continuous current dynamos, and even then there are many objections. As this would be a comparatively low voltage for long distance transmission, continuous current systems stand very little chance of being used for more than comparatively short distances. Another disadvantage is that the motors also must be run at this high potential, unless the current be transformed by a motor dynamo, which is awkward and expensive, as it involves the use of moving machinery requiring attendance. The starting of a motor at such high potentials also introduces difficulties. A point in favour of continuous currents is in the fact that the line is not charged and discharged continuously.

The field is therefore left tolerably clear for alternating currents, who owe it to two features, one that the alternating current dynamos require no commutator, and the other that such currents may readily be converted from a low tension to high tension and the reverse with but a small loss of a few per cent. in each transformation. An alternating current dynamo for generating low potential currents is the simplest kind of a dynamo, and a transformer requiring no moving machinery is a very simple thing to take care of, if, indeed, it required any attention at all. Simplicity, alone, therefore, is very much in favour of alternating currents.

The only serious objection to the use of simple alternating currents for the transmission of power is that they are not so suitable for running motors as direct currents are. There is a class of motors called synchronous motors, which are, as a rule, simple alternating current dynamos used as motors, like in the case of direct currents. These must be run at a speed which must synchronise with that of the dynamo as precisely as if coupled to the shaft of the dynamo. They run very well after they are started, but many of them come to a dead stop if overloaded sufficiently to retard their speed below that of a synchronism, even if retarded only to a slight amount. Their chief fault, however, is that they cannot be started readily; furthermore, all the load must be taken off before they can be started at all. Various methods are used to start them, but although they accomplish the object they can hardly be termed satisfactory solutions of the problem, at least as far as they have come to my notice. This makes them unfit for many purposes, as elevators, street cars, shops, &c. When there is only one large dynamo, which is started, say only twice a day, it can be done by a small inefficient motor or by starting both the generator and motor together, or by some other similar means, but when it concerns the distribution of power as distinguished from mere transmission, this disadvantage becomes of great importance. But it is likely that before very long this problem also will be solved by several methods so as to leave very few objections to the use of alternating currents.

A fair idea of the cost of transmission of power plants may be obtained from the following table of figures given by the Oerlikon company, and taken from plants actually installed by them, mostly in and about Switzerland. The table was copied from a paper read by Mr. Saunders Morris at the Engineers' Club of Philadelphia.

		Cost in dollars.				
Distance in miles.	H.P. delivered.	Generators.	Motors.	Line.	Total.*	Per H.P. delivered.
6·25	11	647	540	2,350	4,700	42·60
·43	510	...	...	...	33,250	65·30
3·75	220	5,190	4,700	3,135	14,500	66·20
1·56	150	3,720	3,525	1,615	10,020	67·20
·56	71	2,155	1,960	294	5,100	71·60
1·87	85	3,135	2,741	2,155	9,220	108·50
2·20	51	1,761	1,567	1,469	5,595	109·40
5·00	41	1,174	980	1,682	5,000	121·10

* This includes regulating apparatus, instruments, poles, insulators, lightning arresters, erection and supervision.

As regards the Lauffen-Frankfort plan, it should be clearly understood that it was to solve the motor problem that a certain modified alternating current system, known as the three-phase system, was used. This system involves the use of three wires throughout in place of two; but it not only overcomes the difficulty of the distribution of power and the starting of motors, but it goes farther, because such motors are very much easier to run, and are simpler in construction than the best continuous current motors, a feature which counterbalances to a great extent the objection to the use of three wires.

Time will not permit a detailed discussion of this three-phase system here; it will suffice to say that it consists of three simple alternating currents—one in each wire—the waves or impulses in the three wires following each other in succession similarly to the relative motions of the three cranks of a three-cylinder steam engine, or the pistons of a three-plunger pump. Such a set of currents produces a *rotating* magnetic field, while the simple alternating current produces merely an *oscillating* field. The rotating field furthermore has a definite direction of rotation. It is this feature of a rotating magnetic field, as distinguished from an

* Abstract of a paper read before the Buffalo meeting of the National Electric Light Association, February 23rd, 1892.

oscillating one, which renders it particularly well adapted to run motors. The ordinary simple alternating current motor may be said to be analogous to a steam engine with one crank, having its slide valve operated by an independent rapidly running engine; it has a dead point from which it will not start; but after it is up to speed, it will run very steadily. The rotating field motor, on the other hand, is analogous to a three-crank engine operating its own valves. There is no dead point, and it can start itself, even with full load.

An interesting feature about this system is that although the three currents have different phases, they need no separate return leads, because the nature of the currents is such that each acts as a return current for the other two in multiple arc. The three circuits are therefore merely connected together to a common terminal, after they have passed through the dynamos, transformers, and lamps. This terminal we will call the neutral point. This neutral point was grounded throughout the system, in the low tension as well as in the high tension circuits, and at both ends of the line. No current, however, will flow through the ground when the plant is working normally.

Both the high tension and low tension circuits were carefully grounded at both ends at the neutral point, that is, at the common junction of the three wires. This makes the system perfectly safe, for in no case can the voltage on the low tension circuit be greater than the normal low voltage. In case of a ground on the line, or a cross between the high and the low tension circuit, the fuses will blow.

From careful commercial measurements it was found that the efficiency from the dynamo current at Lauffen to the lamps at Frankfort was 72 per cent. when about 80 H.P. was transmitted, which is very satisfactory. It is furthermore probable that accurate measurements will increase rather than decrease this figure. It should be noticed that this was the efficiency for only 80 H.P. From this efficiency must be deducted the loss in the generator and that in the motor in order to get the total. After the exhibition closed, the plant was also run at 30,000 volts; during the test one of the insulators failed. The plant was run in all kinds of weather without apparently any appreciable increase of the loss on the line. It was furthermore found that the predicted heavy losses, due to the condenser action, did not exist, and that for practical purposes these losses follow Ohm's law. It will be remembered that this was one of the uncertain features, the existence or non-existence of which this experiment was to prove. As the distance was far beyond that at which power will, in practice, be carried, say 30 or 60 miles, this experiment demonstrates that such a transmission is entirely feasible at distances met with in practice.

The Oerlikon Company gives the following figures regarding the cost of the plant:—Assuming that 300 H.P. is developed at Lauffen, and that all the energy received in Frankfort was converted into light, the cost of the plant per effective horse-power, measured at the terminals of the lamp, will be about $282, of which $236 is for the line alone. These figures appear high, but it must not be forgotten that in this particular plant there were conditions which would not be likely to occur in practice, namely, relatively small power on the one hand and exceedingly great distances on the other, both of which factors naturally increase the cost per horse-power.

It may be of interest to add here that Mr. Dobrowolsky, of the Berlin firm, states that he would be willing to bid on the contract to transmit 1,000 or 5,000 H.P. from Niagara to Chicago, a distance of about 500 miles. He proposes to use 40,000 to 50,000 volts, and claims that an efficiency of 60 to 75 per cent. could be obtained without difficulty.

At the close of his paper Mr. Hering read the following abstracts from a letter which he had just received from the Oerlikon Company, of Zurich, Switzerland, who have made a bid for a plant for the transmission of power from Niagara Falls to Buffalo.

They propose that the system to be used should be such that not only motors, but also arc lamps as well as incandescent lamps, could be supplied by it. They claim that as the drehstrom (that is, the rotary current) is at present, and will be for a long time to come, the only practical form of current to run large motors of a fair efficiency, they have proposed the use of this drehstrom. They propose to use 50 periods in place of 40, which were used at Lauffen, because they say that 40 is too low for running arc lamps, 50 being the lowest at which arc lamps will run satisfactorily. The generating station would be composed of units (dynamo and turbines) of 5,000 H.P. each. The turbine designers have fixed the number of revolutions at 250 per minute. The diameter of the armatures has been fixed at 3½ metres, that is, about 10 feet. The armature is to be drum wound, that means, of course, that the drum winding is on the cylindrical surface of the armature and not across the ends, as we usually wind drum armatures here. The currents are to be 2,000 ampères in each of three circuits, and the voltage 600 to 700. They claim that it is better to revolve the armature instead of the magnetic field, in order to have a minimum weight on the vertical turbine shafts, the weight on one of those shafts being already very great. The shafts are 120 feet long, and their weight, together with that of the armature and turbine, is very great, and must be taken into consideration. The generators are to have 24 poles, and will be separately excited. The efficiency will be in the neighbourhood of 96 per cent., including exciting power. There will be two transformers to each dynamo, as it was not found practical to build a single transformer of 5,000 H.P. The transformers will be artificially ventilated, and only the high pressure coils will be placed in oil. The transformers will raise the potential to 25,000 volts, which they say, "is no longer to be looked upon as a venture." The cost of the whole line will be about 100,000 francs, that is, about $20,000, a small part of the whole. It is to consist, I presume, of simply three bare copper wires on poles; the cheapest kind of a line.

They propose to carry not more than one or two units of 5,000 H.P. on one line of poles, for a number of reasons. They state that 5,000 or 10,000 H.P. can be led on wooden poles at a very moderate initial cost of plant. The lines would terminate in one or more step-down transformer stations that would supply current of 1,800 to 2,000 volts for municipal and street lighting in the shape of alternating currents to be transformed down to the suitable lamp voltage, as is the case in the ordinary transformer system. The cost of the electrical part of the proposed plant, including the generators, exciters, and transformers at both ends of the line (apparently not including the motors) would be about $180,000 for each unit of 5,000 H.P., with an efficiency of 84 per cent. at the low pressure terminals of the secondary transformers. This reduces to $36 per H.P., which is lower than the lowest one in the table in the above paper. The cost of the line reduces to about $4 per H.P., which is about 10 per cent. of the whole.

In the discussion which followed, Prof. Elihu Thomson said: I am greatly in favour of the three-phase system. It seems to me that it is a symmetrical system, one allowing you to do almost anything you please with it. The only question in my mind is to whether you should take your lines over ground or under ground. It is certain that if you went underground you would not require to paint on every pole a skull and crossbones. Currents of voltage up to 15,000 or 20,000 volts are, of course, certain death if a person comes in contact with them. We are approaching the condition of lightning—continuous lightning, not simply a stroke, but a continued stroke, a great number of strokes following each other in rapid succession. It seems to me, all things considered, although, perhaps, it would be a little more costly to begin with, that for moderate distances the cost should not prohibit putting the lines in pipes filled with oil, that is, to use throughout the line the same insulation which is used on the transformers.

In other words, insulate the whole high tension part of it in oil, and bury the pipe. In that case you are practically free from any leakage due to wet insulators or interference due to lightning. It can be said, in favour of a high potential system, that the liability of damage by lightning is less the higher your potential; in other words, the nearer you approach lightning in the operation of your plant the less liability there will be that lightning will interfere with the operation of such a plant. It is constructed to stand a moderate phase of lightning, and it would take a considerable addition to break it down. Oil insulation, furthermore, regulates itself the moment it is punctured. Such a line might in a measure be struck by lightning and might be deranged for a moment, but the oil, passing in between, would end the difficulty. It is very different where the apparatus is not constructed to stand more than 3,000 or 4,000 volts instead of 20,000 or 30,000. There, if lightning comes on to the line and you are or are not provided with all safeguards, the question is whether damage is not going to result.

There are some other points about the three-phase system that I would like to bring out and emphasise. It seems to me that we can do a great many things with it. For example, we can get alternating currents at the receiving end for the running of lights direct from the mains, by conversion down to any voltage. We can therefore run any kind of apparatus which operates with single-phase alternating currents or with multiphase alternating currents. We have at our disposal, as Mr. Hering has shown, motors which can be run—and efficiently run—by the means of the three-phase currents directly fed to them without excitation of the

field; that is, motors which do not synchronise, motors which do not run at quite the proper speed when loaded, but nearly the proper speed, very nearly; motors which run fairly well, and are adapted to distribution here and there. We can also run a machine from the same system of mains, which is a reversed alternating dynamo, and runs perfectly synchronised. If the generating plant runs at 130 to 150 turns, the motor may run at a definite speed depending upon the generator speed, that is, at that same speed or some definite relation to it, and it will stay at that speed, not varying a particle, being perfectly synchronous. In case, for example, we wish to lump all our power in the receiving station and run at absolutely steady speed, we might use the reversed dynamo, or the reversed three-phase dynamo, as a motor getting synchronising speed. We can distribute by the other form, the non-synchronised form of motor, without any field excitation at all.

Suppose we desire to get continuous currents from three-phase currents—suppose, in other words, we have an existing plant which is based upon the use of continuous currents—it may be for street cars that are already equipped; or there may be mains laid in the streets which are adapted to use just certain pressures, and there may be motors running from those mains which are only adapted to use continuous currents; then we have resort to another kind of a machine, a machine which takes continuous three-phase currents and delivers from the other side continuous currents, which has no commutator on this end but simply three wires, and on the other end a low potential commutator, a commutator which gives you no difficulty in running 110, 220, or 500 volts. We may in such a case convert directly from the three-phase currents into a continuous current and supply the existing mains, and we may do that efficiently. We can, therefore, run from the same system a motor generator, as it would be called, which is supplying 110, 220 or 500 volts, either with separate machines, or even in the same machine; furthermore, we can make such a machine so that it will compound itself. In case, for example, the machine is running with very little load, its potential will be, say, 220 volts; if the load is thrown on there will naturally be a fall of potential in the whole transmission from one end to the other, including that in the mains in the streets; this fall of potential can be made up by the construction of the machine; in other words, we can compound this motor generator by simply using the accessory field which Mr. Hering showed in the slide, and exciting that field by the secondary currents; that will raise the potential, and the system then becomes a completely compounded one.

THE CO-EXISTENCE OF DIELECTRIC POWER AND ELECTROLYTIC CONDUCTIVITY.

The method which has been used by Mons. E. Bouty* for measuring the dielectric constant of mica at high temperatures, and which has been duly noticed in the Electrical Review, has recently been employed by him without essential modification to the examination of dielectrics which are endowed with feeble electrolytic conductivity.

Two metallic plates, forming a rigid system, are separated by very small scales of mica. After the capacity, c, of the condenser thus constituted has been measured, the apparatus is immersed in the conducting and dielectric mass. By means of a torsion pendulum the circuit of the condenser is closed upon a battery of electromotive force, E, and of negligible resistance for periods of time, t, which is known and is very short, and the quantity, ϕ, of electricity which passes is collected in a microfarad.

Mons. Bouty finds that it is exactly represented by the formula

$$Q = E(C + a t) \qquad (1)$$

in which equation a and C are constants.

The dielectric constant, k, referred to a *nil* time is

$$k = \frac{C}{c} \qquad (2)$$

This method has been applied to the examination of essence of turpentine, and to the commercial "pure benzine," the conductivity of which is high compared with that of mica.

For benzine it was found that

$$k = 2{\cdot}25$$

which is exactly the mean of numbers previously given by MM. Silow, Quincke, Palaz, and Negreano.

It was interesting to apply this direct method to the examination of distilled water which, according to MM. Cohn and Arons, Tereschin, Cohn,* possesses a dielectric constant 40 times greater than the square of the mean index.

More recently still Rosa† has found

$$k = 75{\cdot}7,$$

and he has stated moreover that this value is not affected by the presence of traces of salts in solution.

Unfortunately the conductivity of distilled water presents difficulties to the working of Mons. Bouty's method, he was however enabled to apply it in the case of ice, with as little difficulty as with benzine, and he found

$$k = 78.$$

In the case of ice, polarisation is unable to exert any greater influence than in the case of benzine, and Mons. Bouty was able to demonstrate the existence of the very great dielectric rotatory power of ice.

As the temperature rises the conductivity increases, but the dielectric constant does not appear to vary much. More marked results were obtained too by using filtered Seine water, or water containing a trace of marine salt.

It is evident from these experiments that the dielectric power and the electrolytic conductivity are susceptible of co-existing in the same substance; and this conforms to the views of Maxwell. Moreover the dielectric constant varies but little under conditions in which the conductivity increases in enormous proportions.

This paper can be consulted in the *Comptes Rendus* for March 7th, vol. cxiv., No. 10., p. 533.

* *Comptes Rendus*, *t.* cxii., p. 1,310, 1891.

* Cohn and Arons. *Wied. Annalen*, *t.*, xxxiii., p. 13, 1886; Tereschin. *Ibid.*, *t.*, xxxvi., p. 792, 1889; Cohn. *Ibid.*, *t.*, xxxvii., p. 42, 1889.

† Rosa. *Phil. Mag.* [5], xxxi., p. 188; 1891.

FIGURES FOR ELECTRIC LIGHT PRODUCTION.

By W. H. BOOTH.

(Continued from page 416.)

II.

For the present we will leave the question of engine-power and discuss that of boilers. For the non-professional man there is no subject which we have found appears to present greater difficulty than the choice of boilers.

Their size and numbers are complicated with the question of coal consumption and other matters more or less puzzling.

For Lancashire boilers and others of similar type and for underfired cylinder boilers having roomy furnaces, it may be laid down as a general fact that a comfortable rate of combustion is from 15 to 18 lbs. of coal per hour on each square foot of firegrate surface. An economical limit with good draught is 21 lbs. per square foot, and a good fireman will accomplish this with good results. In boilers having a shell diameter of 7 feet, 7½ feet and 8 feet, the customary grate areas are 33, 36 and 39 square feet respectively; this is with grates 6 feet long, and it requires a specially good fireman to properly fire and attend to grates anything in excess of 6 feet. The attempt, as often as not, results in the fire burning into holes and admitting a useless excess of air. With a knowledge of grate surface and a predetermined rate of combustion of, say, 18 lbs., we have the means of determining the boiler's work. Taking an 8 feet boiler as having in round numbers 40 feet of grate area, and burning 18 lbs. per foot, we get a total of 720 lbs. per hour.

Such a boiler should evaporate, if fitted with the usual feed-water heater, at least 10 lbs. of water per lb. of coal. This implies that the feed is supplied at over 200° F.

Under favourable circumstances, 11 lbs. may be evaporated, but oftener the amount falls to 9 or even 8, and as we must provide for average conditions, we will take 9 as a basis. Thus $720 \times 9 = 6{,}480$ lbs. of water evaporated per hour. A good engine will use 16 lbs. of water per hour, per horse-power. The above boiler will therefore produce, with a good engine, 400 indicated H.P., and in Lancashire it is held suitable for 450 H.P. under very favourable conditions, whilst 500 has been claimed under specially good conditions. The writer has seen two such boilers driving a full-size cotton mill. We may take 400, however, as a very comfortable rate of work with easy firing and not pushed, and this leaves a good 50 H.P. of margin.

Similarly a 7 feet boiler will do 300 to 350 horse-power, and a 7½ feet boiler 350 to 400.

These are round numbers and may be increased by better draft and higher rates of combustion, but we are dealing with practical everyday conditions where firemen of the quality found in the textile districts are not always to be obtained. The ordinary length of a boiler is four times its diameter. Let us suppose we are called on to provide for 1,700 horse-power. Four 8 feet boilers would easily give this power and there would be a fifth as lay bye. The frontage required would be 40 feet, plus the flue and wall space, or 53 feet in all.

Sometimes the feed-water heater in such an arrangement occupies the position of a sixth boiler, but we prefer that it should, if possible, be placed as in the accompanying sketch, fig. 1., athwart the ends of the boilers, as the arrangement of

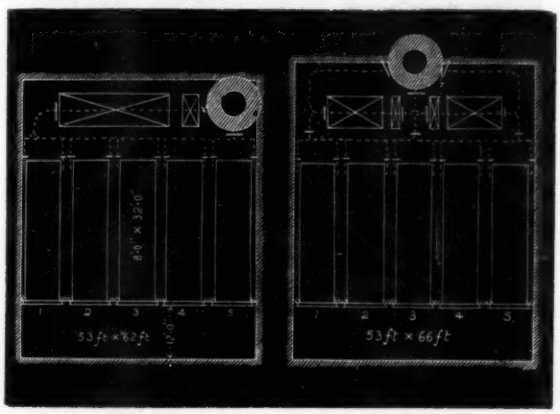


FIG. 1. FIG. 2.

the flues to turn the smoke either through the economiser or directly into the chimney can be conveniently suited to this plan.

We may incidentally mention here for the benefit of those who are concerned with existing boilers, that where a boiler requires to be systematically operated with partially closed dampers it is evidence that the furnaces are being under-worked. The remedy for this is to reduce the length of the firegrates and compel thereby nearly wide opening of the dampers and much thicker fires. The opening of the dampers gives a better draught which will force the air through the thickened fires and produce more intense combustion, an equal amount of coal (less the percentage saved by the better style of working the fires) being burned on a reduced grate area, and the excess of air, beyond the minimum chemically called for, being less.

Of course where very small coal must be burned this advice can only be followed to a modified extent. A long experience has shown that the thickness of a fire may be increased with the size of the fuel used and that the fire thickness must increase with the draught. There is a suitable ratio between draught, fuel size and fire thickness, and dust fuel requires so gentle a treatment that it cannot well be burned at rates exceeding 12 lbs. per square foot per hour, whereas ordinary steam coal of the class known as "burgy" may often be consumed at double this rate. Those who are in a position to obtain dust coal at very low rates must be prepared to double the number of working boilers and add to their boiler house dimensions, and also somewhat to labour cost. It is, however, a mistake to suppose that dust fuel fresh from the mine is at all seriously inferior in calorific power to good steam coal. It is equal to it in evaporative duty but requires a larger area of grate on which to burn, and its commercial value can be ascertained by suitably equating its cost, including interest charges and rent on increased plant, with that of ordinary coal. It is often said that the best is cheapest. This is not always the case with so-called best coal, and where the dust fuel can be shown cheapest there are advantages in its employment. The boilers are less strained by its use, and should business grow and more dynamos require to be driven, the boilers can be long made to serve for the increased power, simply by using a better coal with better draught. The question of water for steam boilers is one too often left to the throw of chance, and yet, weight for weight, an electric station consumes from eight to ten tons of water for each ton of coal burned. At least it ought to be in this ratio, or fuel is being needlessly wasted. In a 1,000 horse-power station, using perhaps 15,000 gallons of water per day of 10 hours, the cost of water will often exceed ten shillings per day, or say £150 to £200 per annum will go for water rate, if there be no natural source available. It is important then, either to secure some such natural source on the surface, or to endeavour to secure a supply by means of a well.

It may be noted incidentally that in ordinarily favourable conditions a manufactory may secure water by means of artesian boring, the total cost of which for a supply of 20,000 gallons per day, may not exceed £300 to £500.

Where engines are of the condensing type, fuel is economised to the extent of 25 per cent., and it is well worth constructing a condensing pond for the purpose of saving this, especially as such a pond need not be deep. Necessarily the larger the better, but where the available area is limited, it is usual to cause the water discharged from the condenser to travel a considerable distance in wide shallow troughs before it again enters the pond, as it is thereby well exposed to the cooling influence of the air.

Where high pressure engines are employed it is common to utilise some of the waste heat in the exhaust steam by a feed water heater, but in cases where condensing engines are employed, the feed water for the boilers is best heated by a water pipe heater (of the style known as the "economiser") and the waste furnace gases. These heaters consist of a series of pipes set in rows in what are termed top and bottom boxes, which are all connected in such a manner that each pipe takes a small portion of the feed water from the lower box and passes it out into its upper box towards the boiler. In practice these rows of pipes, against which the furnace gas first impinges, do the bulk of the work.

It would be out of place here to go minutely into the theory of feed heating, but we may give a few useful figures for reference.

The pipes are about 4 inches internal diameter, and are 9 feet in length.

Economisers are variously made from 5 to 10 pipes in width in a box facing the draught, and the number of boxes may be 30 or 40 or any less number, a common number of pipes for one boiler being 96 in 12 boxes of eight pipes each. It is not usually considered worth while applying "economisers" unless the waste gases are at least 400° Fahr. The feed water, which very commonly enters them at a temperature of 100° from the hot well of the engine, is sometimes heated as high as 300° in its passage through the pipes, though a rise of 150° is more usual.

The smoke should not be cooled below 350°. As a general rule the temperature of the furnace gases may be 600° to 700° Fahr., and it pays better to employ a feed heater than to have another boiler and endeavour thereby to turn out the smoke at a less heat.

"Economisers" justify their name to the extent of 10 to 15 per cent. The proportioning of the number of pipes is very largely a matter of experience. Some allow four pipes for each ton of coal consumed per week of 56 hours, and so give 64 to 96 pipes per boiler. Others allow three indicated horse-power per pipe. For our installation of 1,700 I.H.P. the first rule would give for a coal consumption of 2 lbs. per H.P. hour 340 pipes, the second rule would give 566 pipes. About 400 pipes we should be inclined to advise, with, if possible, a separate batch of 48 to 64 pipes placed on the side towards the chimney, through which all the feed should be first passed on its way to the main economiser.

This prevents the rotting out of the lower part of the pipes by corrosion of their exterior surfaces. This decay effectually destroys the whole apparatus, but may be obviated by the above contrivance of a few separate pipes to give the first few degrees of heat. Of course the whole of the height of the few pipes will be destroyed by corrosion, but only in the same time as would be taken to render useless the larger apparatus. We sacrifice in this way a sixth of the number of pipes and preserve five-sixths, whereas without the precaution we sacrifice the lower sixth part of all the pipes, which is equivalent to their complete destruction in the same short period. The cause of the decay is the condensation of the steam from the furnace gases upon the cold surfaces of the pipes, and experience teaches that only the lower sixth of each pipe length is so cool as to do this. Hence the reason for adding a separate set of pipes, one-sixth of the total number or thereabouts, so that no portions of the main set shall be below condensing temperature. It is the practice at some works to return a sixth or thereabouts of the heated water to the economiser feed pipe. This takes the chill off the cold feed and has the same protective effect as the isolated small group of pipes. It may be added that some men of wide experience in economiser working are not favourable to the plan of separate grouping of the first few pipes.

We now have our boiler house virtually furnished with five 8-feet × 32 feet Lancashire boilers and two economisers of 400 and 60 pipes respectively, the small one delivering water to the large one and then to the boilers. The capacity of an "economiser" apparatus is six gallons per pipe. Our total of 460 pipes contain 2,760 gallons, and this quantity of water will all pass into the boilers with each 3,000 lbs. of coal burned.

Our total grate surface being 160 in the four boilers at work, burning, say, 20 pounds of coal per square foot, it follows that such an economiser contains practically nearly enough water for an hour's work. Of course, if the economiser gets very hot, it begins to deliver steam to the boilers and these begin to require less coal, and so the smoke goes away cooler to the economiser, and these do less work in feed heating. A balance is very soon struck between the two halves of the steam producing plant.

The heating surface thus provided in the feed heater is about 4,640, or 10 square feet per pipe. That of the four working boilers, measured in the fullest manner, is barely this amount. In fact, each boiler has but 800 feet of heating surface by ordinary measurements, or a total of 3,200. The feed heater has thus one and a-half times the heating surface of the boilers which it supplies. Where there is reason to believe that the feed heater may be extended, it is a simple matter to do this by the addition of further sections; but it must be remembered that economisers are to a large extent spoilers of the draught, hence, where to such a set of boilers as we propose, is added a large number of economiser pipes, we should deem it preferable, though probably more expensive, to place one 200 pipe economiser to take the smoke from two boilers, and another of equal size to take the smoke from the other two boilers at work, as shown in one of the sketches, where the division has been effected. In this way we double the end breadth of the economiser by which the smoke enters, for we have two faces of 10 pipes wide. In this way, too, the smoke travels at half speed past 200 pipes instead of at full speed past 400 and the heating effect is the same. The supplementary pipes may similarly be in two sections, or may be in the flue common to both main sections. Much, of course, depends on available space, and the design should aim at the minimum possible of brickwork. The splitting up of the feed heater allows of probably as much reduction of brickwork as balances the increase at other points.

The writer has a great belief in the porosity of ordinary bricks and mortar, and for all exposed flue walls or boiler seatings, would strongly advise a facing of glazed bricks in neat cement mortar to reduce to a minimum the entrance of cold air to the flues which undoubtedly takes place through the millions of pores in a rough brick wall.

For this purpose he has advised the tarring of the external face of rough brickwork flue walls to stop the pores.

Glazed bricks are, of course, better, and very easily kept clean.

So far, nothing has been said of pressures. For modern compound engines of the type to be proposed, the boiler pressure would be 105 lbs. per inch, thus securing 100 lbs. clear on the pistons and a margin for the safety valves. This is an easy pressure for first-class boilers, not too severe on the engines and yet one giving a fair degree of economy. Good enginemen will secure as good results from old 60 lbs. pressure boilers and old-fashioned beam engines as less careful men will get out of the most modern appliances. So very much depends on the careful upkeep of both engines and boilers, that we should prefer to advise 80 lbs. boiler pressure when there is any doubt of the attendance; for with every increase of pressure there is an increase in wear and tear, attendance, oil, &c.

In proportioning the flues about a steam boiler, theoretical questions find very little room.

The smallest flue advised at any point is one which will easily pass the inspector or sweep. This fixes the desirable minimum, and this minimum in the main flue of a single Lancashire boiler will be usually 2 feet wide and conveniently 6 feet high. The cross-sectional area is 12 square feet, which is sufficient for three boilers. Chimney areas are governed by a rule which embodies the grate surface and height above fire bar-level as factors, and a chimney is well

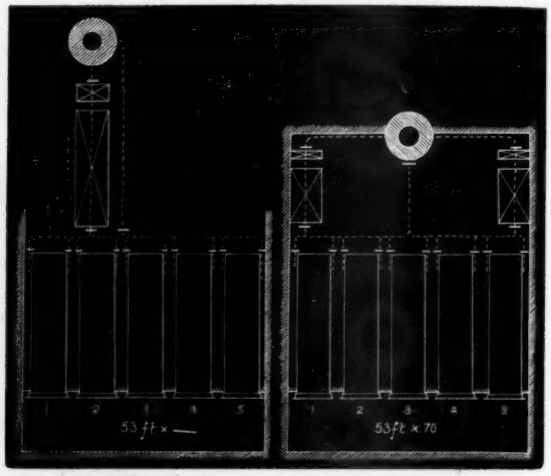


Fig. 3. Fig. 4.

proportioned for its duty when, for a combustion of about 20 lbs. of coal per foot of grate surface per hour the area of the chimney is from 1½ to 1 times the grate area served divided by the square root of the height in feet, the larger area belonging to a single boiler, and the smaller to a battery of four or more boilers.

In the present case, where there is a grate surface of 160 feet, the chimney area for a height of 150 feet would be from 13 to 20 feet. For such a power, however, a 200 feet chimney is preferable, and our own rule has been to allow a minimum of 4 square feet area for even 7 feet boilers, and in the present case we should advise as a minimum a chimney of 5 feet internal diameter at the base, widening out towards the top to 5 feet 6 inches; while if there is a prospect of additional steam-power and more boilers, a 6-feet chimney will be none too big.

Like all other items of mechanical engineering, chimneys will accommodate themselves to changed conditions. A chimney, it must be understood, does no work. It is merely a tube through which hot gases are forced by the pressure of heavier cold gases. A chimney is ignorantly said to have a drawing power, but this is a statement based on an entire misconception.

With this series of articles there appear several arrangements of the boilers, heaters and chimney, as examples of standard arrangements to fit certain enforced locations of the various parts.

Of these, Nos. 1, 3, 5, are very usual arrangements, except for the small or primary heater, which is usually, but mistakenly, omitted. Nos. 2, 4, 6, and 7, are given as ideas of what could be advantageously arranged with varying conditions as to chimney, &c.

The main point is to secure the shortest route to the chimney for the flue *viâ* the economiser. There is always a

by-flue direct to the chimney for times when the economiser is stopped for cleaning or repairs. One advantage of a double economiser is that one-half can be at work when the other is being cleaned and the boilers are never fed with cold water. In each arrangement if one is shut out all the boilers can send their smoke through the other apparatus.

For electrical work where a double system is so often employed it is always desirable to reduce capital expenditure to a minimum, and in a large station the division of the steam generating apparatus into sets of two or three boilers, all of which can be worked together and where the flue arrangement is such that elasticity in the working of the feed water heater is secured, there is reduced necessity for

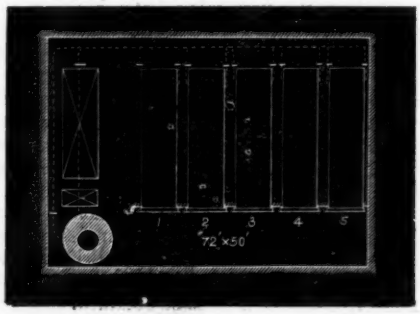


Fig. 5.

duplicate apparatus, as one part can be pushed in event of failure of another and made to do extra duty. One spare boiler as a rule will be quite sufficient for several working boilers. A spare boiler merely allows time for the proper cooling down of each boiler in turn before cleaning and for its subsequent cleaning and restoring. As two boilers may be cleaned per week, the number of working boilers for each spare boiler may be twice the number of weeks which a boiler is worked between times for cleaning, and this depends on the nature of the water used and the degree of efficiency of any automatic apparatus for removing deposit from a boiler at work.

One spare boiler in six working would be a fairly liberal allowance.

In Lancashire, one in four or one in five, are usual numbers, and one boiler is cleaned per week.

Though the sketches show the chimney within the boiler house, this is not, as a rule, to be practised. The chimney should stand some way outside and free of other buildings. Where space is an object, several inches of width per boiler may be saved without seriously deteriorating from good practice if intelligently carried out, and the seven sketches

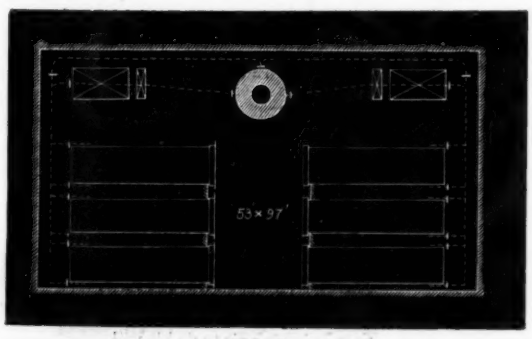


Fig. 6.

by no means represent minimum possible spaces, nor, indeed, do they represent the maximum which may be found, but they are more specially given as an indication of possible arrangements.

In No. 7, for example, a possible extension might be made by placing an additional boiler in the gap between the other two sets. Gaps of this kind are best left, where possible, of the width demanded for a boiler and its brick walling. In such a case the main flue would be carried underground if the chimney stood where shown.

In this figure, too, the economiser might have stood in the gap over the main by-flue had there been no room at the rear. The vacant spaces in figs. 3, 4, 5, 6 and 7, are utilised for feed and fire pumps, workbenches and stores.

Where space is of more importance, it is often easy to much reduce the areas given in the sketches. The economiser, for example, by no means necessarily stands on the same level as the boilers. It may in fig. 1 arrangement, for example, be placed much nearer the backs of the boilers and stand over the main flue, so saving something like 6 feet out of the 62 feet of length inside the walls of the house. If needful, the 53 feet may be reduced to 48 ; the 12 feet to 9 feet ; and the boiler length of 32 feet to 30 feet, and so on, narrowing the economiser and adding to its length, so that the same power could be got into a room 48 feet by 45 feet, or 2,160 square feet by a careful design, which would still give ample flue area, but would make some addition to cleaning difficulties. Indeed, the writer has been accustomed to name 400 square feet per boiler as the minimum for a set of Lancashire boilers with all equipment, but does not advise it outside crowded centres.

It may be added that in cities, where space is an object, there is as little difficulty in double banking Lancashire boilers as any other type. An 8 feet by 32 feet boiler, in working order, may weigh one ton per foot of its length, or, say, 200 pounds per square foot of floor surface, to which the brickwork may add a further 200 to 300, a by no means serious floor weight over a length of 32 feet only.

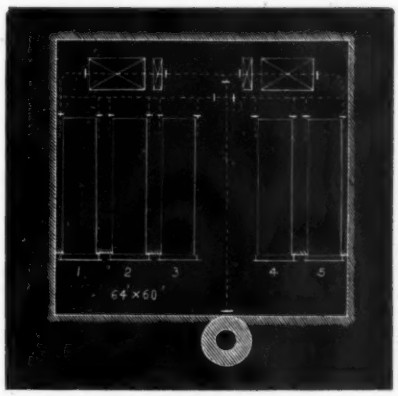


Fig. 7.

Water tube boilers are often placed floor above floor in America. This is a mere constructional detail not perhaps worth considering under the question of a country station.

It may be added that the entance of the main and by-flues into the chimney at right angles to each other, is only thus shown to make the sketches complete. In practice, with a more distant chimney, the two flues coalesce at an earlier point, and only one opening need occur in the chimney.

(To be continued.)

ECONOMY IN ARC LIGHT WIRING.*

By S. H. SHARPSTEEN.

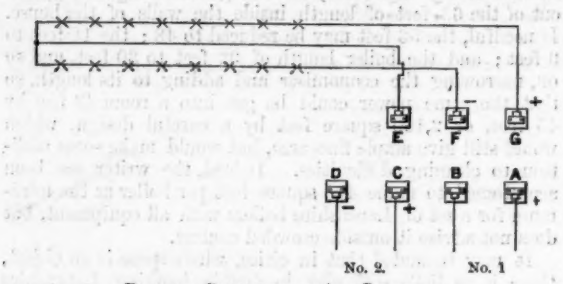
There are many towns throughout the country that have from 50 to 80 arc lamps and possibly many to be installed, of about the same number. Continuous service with a small amount of copper, with certain amount of loss of energy allowed, are important questions. If the town is long and scattered, copper will be a large item and must be used as economically as possible.

The first thing usually done is to put both municipal and commercial lamps on the same circuit, possibly with one large machine. The work is done in a hurry and the townspeople think with the stockholders and directors, possibly, that the plant shows much engineering skill. Fall comes with its

* New York *Electrical Engineer.*

long nights and the superintendent finds that he has got to burn his street lamps much longer, by far, than there is any need of. The final result is that another circuit has got to be run, the commercial lamps put on one, and the municipal lamps on the other.

About three years ago I adopted the following method and have found it to work well. By referring to the figure one can see that all the arc lamps were put on two legs of wire; the commercial lamps on one leg marked G and the municipal lamps on leg marked F. A third wire was started from a switchboard terminal, E, just to the left of the other two and run out on the pole-line until it came to the last commercial lamp and was there connected to the leg containing the commercial lamps.



Plan of Circuits for Arc Lighting.

The circuit went on some distance farther containing municipal lamps, but all that was necessary was to run past the last lamp of either leg. In the case referred to here there were two machines worked in series, the switchboard terminals of one being C and D, and of the other, A and B. Since the two were driven from the same countershaft with friction pulleys, when the commercial lamps were wanted, machine No. 1 was started and by means of the usual cables and plugs, A and G, were connected together; and also B and E; the result was that the commercial lamps were lighted.

Later on when it was dark enough to want the street lamps, machine No. 2 was started, the brushes put down at point of minimum working capacity when by means of the remaining hole in the terminal, B, the latter was connected with C; and by means of the remaining hole in E, E was connected with D. The result was that machine No. 2 was in circuit with no load, and if brushes were not at the point above referred to they would burn. The next thing in order was to disconnect E and B, which put both machines on the commercial circuit. Now to get E out and F into circuit, one plug of the cable just taken off from the switchboard was put into the remaining hole at D. The other plug was put into the right hand and held near F until the plug in E was withdrawn far enough to draw a short arc, when the plug held in the right hand was put into one of the holes in F, when the arc at E let go and both lamp legs were on both machines. In this connection one might say, "Why not leave plug in E until plug is into F?" This would be all right if machines were automatic in regulation, but if not, the current would be apt to increase in quantity since there would be two paths for the returning current and resistance decreased. One good feature of having two machines is to make partly sure of always having the commercial circuit working. In case of an accident or some little thing occurring that causes the shutting down of one machine the other machine can be made to work the commercial lamps alone.

ELECTRIC LIGHTING AT COLOGNE.

We have received a schedule of regulations and conditions laid down for carrying out electric installations in the city of Cologne. From this document we extract the most important points.

The price for the supply of current is fixed at 4·4 pfennige (100 pfennige = 1 sh.) hourly for a 16-candle glow lamp. For an arc lamp at 400 normal candles, using 350 watts, there are to be paid 28 pfennige hourly.

The current is supplied from the works as an alternating current in general at the tensions of 36 and 72 volts.

The leads are to be of the best so-called electrolytic copper; its conductivity, at a temperature of 15° Centigrade, being at least 55 times that of mercury.

Under no conditions will it be allowed to use as conductors the earth, exposed rails, gas and water pipes, or any metallic parts of buildings.

All parts where the leads might be exposed to malicious or accidental injuries, must be protected by special arrangements.

Where the leads are conveyed through walls, they must be enclosed in tubes of porcelain, glass, or vulcanite, the ends of which must project at least 1 centimetre from the wall. When the leads pass through floors, they must be enclosed in similar tubes, the ends of which must project at least 10 centimetres above the floor. One wire only must be conveyed in each such tube.

Where wires pass from the interior of houses, &c., into the open air, tubes of porcelain or vulcanite must be used with funnels opening downwards.

At ramifications, or at the crossing of two leads, the wires must be carefully secured, and must either be separated by solid insulating matter, or must be conveyed past each other in loops.

The intersections of telegraph or telephone wires must be effected as nearly as possible at right angles. Where it is necessary to carry the light leads parallel with telephone leads for a length exceeding 10 metres, the special decision of the municipal direction must be obtained.

Intersections of the leads with iron bearers, gas or water pipes, or other metallic structures, are to be treated like intersections of two wires. The illuminating leads must be conveyed at a distance of not less than 50 centimetres from telephone and telegraph wires.

The resistances for glow and arc lamps must be of such dimensions that their fusion is not possible.

THE ARTIST TO THE ENGINEER.*

The mother of all progress, Discontent,
Did first bestow the steadfast vision clear
Of present evil to improvement bent
Alike on artist and engineer.

True servants of the world, twin brothers they;
One bringeth knowledge of earth's loveliness,
And yet that he is greater who would say
Than he who earth with health and wealth doth bless.

To him the river's rippling waters shine
That in her shoals his bridges' piers may stand;
No worshipper at Lady Beauty's shrine.
He clasps great Usefulness', her brother's hand.

Unto humanity the faithful friend,
He raised the weight that need had bound so fast
From shoulders bent with toil that had no end
And on the senseless steel the burden cast.

The mighty civiliser, he unites
The severed continents; his monster slaves
Speed o'er the desert sands a line of lights,
Or gnaw to foam the erst unconquered waves.

Into the regions of eternal night,
Deep in the close-barred cellars of the ground,
He pierces unafraid and drags to light
The thousand priceless treasures that abound.

That wondrous force, a light without a form,
Which with its strength the vaulted heavens did thrill,
Lo! he has drawn the spirit of the storm
From out the quivering air to do his will.

Through the green twilight of the rocking deep
Where fish sweep by in many a glittering band
And myriad strange and shapeless creatures creep
All silent passes thought from land to land.

Thou engineer, who to the earth has given
A higher life, more happy, full, and free,
Go forth! A golden day dawns in the heaven
And greater triumphs surely wait for thee!

Sara King Wiley.

* *Cassiers's Magazine.*

SOME ELECTRICAL INSTRUMENTS.*

By ROBT. W. PAUL.

THE increasing number of cases in which accurate electrical measurements have to be made, renders it more than ever necessary to devote attention to the design of instruments with the object of making their use more convenient and expeditious, as well as accurate. Consider for example, the form in which the standard ohm is usually constructed, the coil having two or more layers of many turns each; in using such a coil for accurate measurements there is considerable delay in waiting for the temperature of the coil and water-bath to become uniform and equal, and even then an uncertainty remains as to whether the turns near the top of the coil are at the same temperature as those at the bottom.

After heating the bath, even with stirring, the water at the top may be at a higher temperature than that at the bottom. The surface, too, from which heat generated in the coil may be got rid of by conduction and convection is comparatively small.

Prof. Fleming, in a paper read before this Society in November, 1888, pointed out these disadvantages and described a coil in the form of a ring of square section, which, to a great extent, obviates them; but even this coil has some length, and it has seemed possible to go still further in this direction, and at the same time to simplify the construction.

In the ohm coil shown in fig. 1, the wire is wound in a flat spiral, being first doubled on itself in the usual way to avoid self-induction; the spiral is enclosed between two thin brass plates, forming part of a very thin, flat, watertight box, and the electrodes pass up the central tube. The wire is thus at one level in the liquid, and has,

FIG. 1.

therefore, a better opportunity of acquiring a uniform temperature, which may be accurately ascertained by a delicate thermometer passing down the centre, with the bulb at the level of the spiral; a second thermometer in the water, at the same level, serves to check the uniformity of temperature. In order that the width of the coil may not prevent any slight convection currents from having free play, the screws which hold the plates together have large holes through them. Following Prof. Fleming's suggestion, the upper ebonite insulator is formed into a cup to contain paraffin oil to prevent surface leakage through deposited moisture.

The resistance box shown in fig. 2 is the outcome of some attempts to improve the ordinary form. The coils are arranged in sets of 10 each, and their ends are connected to sockets fixed in rows on an ebonite board. Successive coils are put in circuit by placing a plug, attached to a flexible cord, in the required socket; thus the resistance

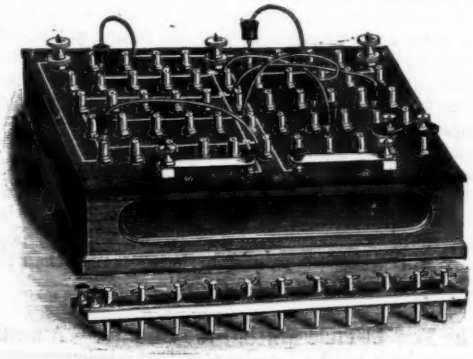


FIG. 2.

may be increased from 1 to 11,110 ohms by steps of one ohm. The advantages which accrue from this arrangement are found to be as follows:—The danger of surface leakage across the ebonite from block to block in the ordinary form, where the narrow gap between them is not easily kept clean, is obviated by the large open space between the sockets. The contact resistance in circuit is constant, and easily measured; it is reduced to a minimum by the fact that each plug fits solidly, the contact being over the whole of its circumference, instead of on about one-third of it, as in the ordinary form. The hole between the blocks of an ordinary resistance box alters its form with the temperature, or any warping of the ebonite board, but the contact resistance at these sockets is not affected thereby. A rise in temperature of 20° C. will make the longer diameter of an ordinary resistance box plug-hole one-half per cent. greater than the shorter, owing to the difference between the coefficients of expansion of ebonite* and of brass. The flexible cords each consist of between two and three hundred strands of fine copper wire, and are found to be unaffected by use.

In using the set of coils as a Wheatstone bridge, or as an ordinary resistance box the rapidity and ease of adjustment of the well-known "dial" form are preserved, whilst the instrument is more compact and portable; the plugs, being attached to the instrument, are not liable to be mislaid.

But the arrangement of the instrument renders it available for several other uses. By means of the special contact bar, shown in the illustration, from 2 to 10 coils in each row may be placed in parallel, thus making the instrument available as a conductivity box of large range, for measuring low resistances. For the measurement of currents by the voltmeter method, 10 one-ohm or 10 one-tenth ohm coils may be placed in parallel to give accurate resistances of ·1 or ·01 ohm of good carrying capacity. Several derived circuits may be made in the one resistance box. By means of the contact bar, large ratios between two resistances, of great importance in the construction of high resistances, may be accurately obtained. To do this, the method described by F. Kohlrausch† is employed; for example, one set of 10 coils being put in parallel, so as nearly to equal the other set of 10 coils in series, the small difference (error) between the two is ascertained by Foster's method; then each of nine of the higher resistances being checked against the first of its series, all the data for finding the exact proportion between the first coil of the one set and the other set of 10 in parallel are ascertained.

The set of coils may be used as a potentiometer by connecting the battery to its terminals and using a pair of travelling plugs, between which any resistance from 1 to 10,000 ohms may be included.

The reflecting galvanometer, illustrated in fig. 3, has coils enclosed in ebonite boxes turned out to fit them; they are wound in accord-

FIG. 3.

ance with Sir W. Thomson's law for the greatest magnetic effect at the centre; each being provided with its own terminals, they can be joined up as desired, and a pair of high or of low resistance coils may be used on the same instrument. When used as an astatic galvanometer, one of the needles is placed at the back of the mirror moving in the thick metal box below the coils, and the plug which carries the window in front may then be pushed in to aid in damping the vibrations of the needle by air-friction. The needle may be easily removed, the suspending fibre passing through a slot in the case. It can be replaced by a ballistic needle, in which case the mirror carries no magnets, and the air-damping can be minimised by sliding out the plug. This part of the instrument is mounted on an ebonite pillar so as to give good earth-insulation, and the directing magnets are placed near the base, so that they may be adjusted without setting the instrument in vibration.‡

* Paper read before the Physical Society, March 25th, 1892.

* As given by Mayer, *Amer. Jour. Sci.*, xli., p. 54, 1891.

† *Annalen der Physik und Chemie*, xxvi., 1887.

‡ The instruments are made by the Author at 44, Hatton Garden, E.C.

THE ENGINEERING EXCHANGE.

A meeting was held at the Cannon Street Hotel, on Wednesday, April 6th, for furthering the objects of an Engineering Exchange. The Exchange is intended to form a central address and place of meeting for persons interested in engineering business, and as a rendezvous for country members and foreigners visiting London on engineering matters. The rooms will be furnished for correspondence, postage, periodicals, telephones for London and provinces, and boy messengers. Desks and lockers will be provided as far as premises will permit, for the private use of members paying a special fee in respect of same; and a patent and reference library will be established.

A crowded meeting resulted from the issue of the circulars, the scheme evidently exciting much attention. The meeting was mainly composed of what are termed "commercial engineers" and merchants employed in the exportation of machinery. A small sprinkling of professional engineers and electricians were also present. Mr. Reginald Bolton, being voted to the chair, explained the objects and advantages of the Institution, and was followed by other speakers.

The following resolutions were adopted:—

"That this meeting, having heard the proposals of the preliminary committee, approves the project of an engineering exchange in London, and pledges itself to support same."

"That a committee be formed, with power to add to their number, for the purpose of organising and opening the exchange immediately, to hold office until the first general meeting of the members; due notice of which to be shortly given."

"That the Committee of the Engineers' Exchange is hereby requested to make suitable arrangements with the directors of the Jerusalem Exchange, and to co-operate with them for the erection of permanent premises."

There was an unanimous spirit throughout the whole proceedings, and doubtless the exchange will commence with strong support.

END OF THE COMPOUND WINDING CASE.

In our issue for July 25th, 1890, page 86, we had occasion to congratulate the electrical trades on the fact that Messrs. King, Brown & Co., with splendid determination and pertinacity, had twice succeeded in carrying their case on the question of the compound winding. Again, and for the last time, they have successfully withstood the Brush pretensions, and the House of Lords has determined, once and for all, that to Mr. S. A. Varley must be ascribed the merit of inventing series-shunt machines. The article to which we have referred meets the present judgment so completely that it is quite unnecessary to devote much space to further consideration of the matter, but we cannot allow the opportunity to occur of paying another well-deserved compliment to the intelligence of English judges without taking due advantage of it. In the case of the Lane-Fox patent, so recently disposed of, we felt it incumbent upon us to draw attention to the high intellectual powers of our legal luminaries, and now, with the compound winding case as the most recent example of law as the highest form of common sense, we cannot help expressing the opinion that our judges seem to have the gift of understanding and accurately adjudicating upon cases in a few days, which take some professors and electrical experts as many years to grasp, and then but very incompletely at the best.

Because shunt winding was unknown to Sir William Thomson before 1879, it by no means followed that this method of coiling was so to others. Sir Chas. Wheatstone had a shunt wound machine, with which we often experimented years before the above-mentioned date, and Lord Watson was fully appreciative of the fact that, although Sir William did not know of it, it was no proof that others were equally in the dark. His terse comments upon patent rights are equally to the point, and, indeed, his exposition of the law is a model of perspicuity and forensic acumen.

There must be quite a number of modern electrical experts who are now experiencing the very uneasy kind of feeling induced by a gradual awakening to the fact that they really do not know one-half of what they are credited with. Their lack of knowledge of past researches and their utter failure to comprehend plain language have been most painfully exemplified lately, and the value of the expert witness in guiding the exponents of the law to their decisions seems to have indeed reached a very low ebb. Mr. Varley is to be sincerely congratulated upon having found his work so completely acknowledged both in the Scotch and English Courts, for it must be a real pleasure after the years of studied neglect to which he has been subjected, and the unwillingness generally displayed to admit his claims as the inventor of both the self-exciting dynamo and its compound winding, to find himself triumphant over all his adversaries.

This judgment disposes of another attempt to control a very important factor in electric lighting, and the trade at large must feel highly gratified that a Scotch firm and a London company have had the courage to contest and break down two patents which, had they been upheld, would have virtually monopolised the use of both dynamos and secondary batteries. We have already suggested that the Edinburgh electricians and Mr. Varley deserve the greatest consideration at the hands of everybody concerned in the compound winding issue, and we shall be much surprised if some public recognition of their invaluable services to the electro-technical industry is not forthcoming.

NOTES.

A Fundamental Patent for Alternating Currents.—A patent has just been issued in the United States which appears to claim broadly the transmission of electricity by means of high tension alternating currents, which are transformed at the distant station to low tension currents by means of some induction apparatus. The patent has been issued to Marcel Deprez and Jules Carpentier. The application was filed in the United States Patent Office November 27th, 1888, after having been patented in France April 5th, 1881, and in Great Britain on September 24th of the same year. One of the claims of the patent as issued, is as follows:—"The improvement in the art of transmitting electrical energy to and utilising it at a distance from the source, which consists in generating maintained and practically uniform alternating currents of high tension at one station and sending the same over a line of conductors to another station, generating maintained and practically uniform alternating currents of lower tension at the second station by the inductive influence of the high tension currents, and converting these maintained low tension alternating currents into other forms of energy, such as heat, light, &c., substantially as described." Our contemporary, the New York *Electrical World*, remarks with reference to the matter:—"The immediate effect will probably be litigation, and there will be much of it, too, if there is any chance of its being sustained. That such an occurrence is possible in our patent office is unfortunate, and cannot fail to have a very bad effect on the investments in patented articles in this country. As it is, anyone who wishes to start the introduction of some article, patented or not, will never know if there is not some fundamental patent lying dormant in the patent office to be thrust upon him unexpectedly at some future date, after he is well established in an honest business. Such a law is like some others in this country, for the benefit and profit of lawyers rather than for the good of the people. Let us hope the patent will prove to be a dead letter rather than a legal monopoly or even only a scarecrow."

The New Electric Station for Dundee.—A meeting of the committee of the Dundee Gas Commissioners appointed to consider the question of the new electric lighting station for Dundee was held last week. Mr. Urquhart, of Messrs. Urquhart and Small, London, the engineers, attended the meeting and submitted plans, along with necessary explanations. The plans were duly examined, and these were remitted to Professor Kennedy, London, for his opinion.

Siemens and Halske.—Our New York contemporary, *Electricity*, announces that Messrs. Siemens and Halske intend establishing an American branch of their famous works. It seems that this firm, having such a good reputation for first-class work, and representing, as they do, such a high standard of electrical construction, "so different from that with which the Americans are familiar," will be most gladly welcomed by private electrical concerns there. Taking into consideration the consolidation of the Edison General and the Thomson-Houston Electric Companies, and the to-be-feared joining of the Westinghouse Company with these two companies, and also the enormous competitive power of such an influential concern as this would be, it would appear, unless almost miraculous interference were made by some strong "back-boned" firm, that private and smaller enterprise would be absolutely crippled, and the complete monopoly would fall into the hands of the combined companies. The proposal of Messrs. Siemens and Halske to open a branch in America has, therefore, met with acclamation from the smaller manufacturers of electrical apparatus. The firm, as our readers are aware, is one of enormous capital, influence, and strength, and is well prepared to fight against competition. It is intended at first to instal a temporary plant at a cost of £100,000, but as soon as productive a permanent plant, to cost £600,000, will be erected. Our contemporary hopes that the competition will eventually result in improved types of apparatus. We thoroughly agree with *Electricity* in its closing paragraph, which reads as follows:—"We believe it would result in advantage to all concerned if Siemens and Halske should come among us. We believe there is no better demonstrated truth than that competition is not only the life of trade, but that the public is the ultimate gainer thereby." It will be exceedingly interesting to watch the procedure of matters in this direction, and to see what the ultimate result will be.

National Telephone Company's Staff Dinner.—Last Friday week the London staff met at a dinner held at Anderton's Hotel, Fleet Street. Mr. Dane Sinclair occupied the chair, and had gathered round him nearly a hundred members of the staff. The gathering was a great success, the proceedings being marked by wonderful unanimity and good feeling. After a substantial dinner, the evening was devoted to music and toasts. The chairman, in responding to the toast of the company, spoke strongly on the telephone system, and appealed to the staff to stand by the company.

Electric Lighting for Antwerp.—In the report of the directors of the Antwerp Waterworks Company, Limited, the directors state that the Antwerp electric lighting contract, providing for the use of hydraulic power in the production of light, has been formally agreed to by the Communal Council of Antwerp, the representatives of the new electric lighting company, and their own company. The Provincial Authority is the only remaining party to the contract that is withholding its consent; but no real difficulty is apprehended, as the objection refers to a technical point only. It is anticipated that good results will accrue to the water company upon the completion of the necessary works, which will provide a guaranteed net income of at least £500 per annum.

Wrexham Town Council and Electric Lighting.—The Wrexham Town Council have decided to enquire as to the price the electric lighting company would charge for handing all the electric lighting business and interests over to the council. The company, it seems, are not unwilling to sell, and the council are desirous of purchasing.

Liverpool Corporation and Electric Lighting.—We hear that the Watch Committee of the City Council are of opinion that it will not be advisable to adopt electric lighting for the City of Liverpool at present. They consider it advisable to do this, "having regard to the conditions of rapid development to which the system of electric light is now subject."

Obituary.—Our New York namesake announces the death of Mr. Charles L. Van Depoele, which took place on the 18th ultimo. He was a well known electrician and able inventor, and was only 46 years of age.

Blackpool and the Electric Light.—At a public meeting of Blackpool tradesmen and others, held last week, the following resolution was passed:—"That this meeting of tradesmen and others considers it to be the duty of the corporation to instal Blackpool with some system of electricity for private and public purposes during the present year, to prevent the outside companies from obtaining such powers."

Benardos System of Electric Welding.—In a recent issue, our contemporary, *Industries*, had an article on "An objection to electric welding," calling special attention to the effect of the arc upon the eyesight. Messrs. Lloyd and Lloyd have written to our contemporary protesting against some of the remarks, as follows:—"For two years now we have had the Benardos process at work in our Coomb's Wood Works on a large scale in the manufacture of large tubes and fittings, elbows, bends, &c., for marine engineering purposes, constructed of steel, and we have not, during the whole of that period, had a single case in which the eyesight of the operater suffered permanently from the light emitted by the electric arc. We may say that we universally use a specially prepared extremely dark non-actinic ruby glass, the ordinary blue glass, or non-actinic photographer's glass, being entirely useless for the purpose."

A Regulator for the Arc Light.—Mr. W. C. Peckham, in an article in the *Electrical World*, describes a regulator which he has successfully used for fixing the arc in the front of the carbons and preventing its flitting about. The device consists of an electro-magnet, the poles of which are set behind the arc. This electro-magnet is wound with a few turns of No. 12 insulated copper wire, just enough to furnish the requisite repulsive force upon the arc. The cores project about 1½ inches beyond the coils, so that these are set back beyond the great heat of the arc, which would destroy their insulation. The wires are connected so that both poles drive the arc toward the farther, or front, side of the carbons, and it will not approach nearer to the poles of the magnet, of course. The fact of this repulsion of the arc by a magnet pole is not a new discovery, nor is its use for certain purposes, but the application has not before been applied in actual practice. Wherever it is desirable to hold the arc in a definite position this regulator has value. It can easily be attached to any form of lamp, focusing or search light.

Non-Arcing of Metals.—Mr. A. J. Wurts, in a paper read before the American Institute of Electrical Engineers, points out that as the result of experiments he finds that a peculiar non-arcing property is presented by certain metals of the zinc and antimony groups. The metals tested were zinc, cadmium, mercury, magnesium, antimony and bismuth. When an alternating current arc is sprung between electrodes formed of these metals over a short air gap it will not be maintained as with electrodes of other metals. Another peculiar property is that when the air gap is a long one the arc will be maintained. Thus, if a 1,000 volt alternating current be arced by priming with tinfoil between two brass (zinc and copper alloy) electrodes separated from $\frac{1}{16}$th to $\frac{1}{64}$th of an inch, it instantly dwindles to a spark no larger than a pea and is destroyed, but if the same current be arced through ¼ to 2 inches air gap the arc will be maintained. Whatever the cause, the fact, says the New York *Electrical Review*, is of importance in making possible a simple and efficient lightning arrester. A few rods of brass mounted in a marble frame and forming a rigid structure constitutes the lightning arrester—meeting on all fours, in point of simplicity, with the well-known saw-tooth arrester.

The Rights of the Postmaster-General.—According to the *Financial News*, an information was laid by the Attorney-General for the purpose of obtaining a declaration defining the right of the Postmaster-General in respect of telephone wayleaves over the system of the North-Eastern Railway Company, and to restrain the company from infringing that right. Terms, however, had been arrived at, and the Court made a decree in the form arranged. It was said that two telephone companies who were parties to the matter—the Northern District Telephone Company and the National Telephone Company—had never run any wires except with the assent of the Postmaster-General, and that there was no order for costs against them.

Electrical Instrument Making. — Messrs. Whittaker will shortly issue a fifth edition of Mr. Bottone's work on "Electrical Instrument Making," revised, with additional chapters containing a few simple instructions for making a small arc lamp, an incandescent lamp, a current reverser, &c.

Electrical Testing.—A fifth edition of Mr. H. R. Kempe's "Handbook of Electrical Testing," published by Messrs. Spon, is now in the press.

The Lane-Fox Patent.—The following notice appeared in last Wednesday's *London Gazette*:—"In the matter of Letters Patent, bearing date October 9th, 1878, numbered 3988, and granted to St. George Lane-Fox, of Telegraph Street, in the City of London, for the invention of "Improvements in Distributing and Regulating the Electric Current for obtaining Light by Electricity and in the means or Apparatus employed therein." Notice is hereby given, that it is the intention of the above-named St. George Lane-Fox, of 66, Victoria Street, Westminster, of the Lane-Fox Electrical Company, Limited, who are beneficially interested in the above-mentioned Letters Patent, to present a petition to Her Majesty in Council, praying that the said Letters Patent may be extended for a further term; and notice is hereby further given, that on May 9th next, or on such subsequent day as the Judicial Committee of Her Majesty's Privy Council shall appoint for that purpose, application will be made to the said Committee that a time may be fixed for the hearing of the said Petition; and any person desirous of being heard in opposition to the said Petition, must enter a caveat to that effect in the Privy Council Office on or before the said May 9th next.—Vandercom & Co., 23, Bush Lane, E.C., solicitors for the petitioners."

Toynbee Hall.—The Committee of the Science Conferences for Artisans and Mechanics now being held at Toynbee Hall, 28, Commercial Street, E., has for its object to lead workmen to ask "the reason why," and to give them the opportunity of obtaining an answer when they do ask. The success of these conferences has been largely due to Mr. W. H. Preece, who has on three evenings this year drawn interested audiences to his lectures on the dynamo and telephone. The lectures are followed by questions from the audience, and some very practical queries have been put. Electricity has proved to be the subject which draws the largest audiences, and it has been decided to limit the scope next year to electricity and chemistry. A laboratory where some practical work with the Wheatstone bridge, &c., can be carried out will be added next winter, and other apparatus added as the demand arises. On April 13th Mr. R. J. Jones (of Messrs. Woodhouse and Rawson) will open a conference on electrical installation work.

High Frequency Discharges. — The extraordinary enhancement of high tension discharges when accompanied by high frequency of alternation has just been shown in a most marked degree by experiments made in America by Prof. Elihu Thomson. They also show in a striking manner the influence of the number of primary turns on the rate of oscillation, so that a given condenser requires a primary in unison with it to obtain the maximum effect. Thanks to the courtesy of Mr. Joseph Wetzler, of the New York *Electrical Engineer*, who has sent us the original photograph of a 30-inch spark under a pressure of 500,000 volts, we shall be able to reproduce Prof. Thomson's researches in our next issue.

Balloon Society.—At a meeting of the council, the Merrett silver medal was awarded to Captain Benest, C.E., A.M.I.E.E., late of the *Retriever* telegraph ship, for his distinguished services, and his paper on Electric and Telephonic Coast Communication.

The Three-Wire System.—The New York board of fire underwriters has condemned the practice of earthing the neutral wire in the three-wire electric light system as being dangerous.

Electric Lighting at Coatbridge.—It is expected that operations to erect plant for supplying Coatbridge with the electric light will be commenced at once. The company have paid the Board of Trade a penalty in consequence of the non-fulfilment of their original license. A trial has been made with good results.

Personal.—Mr. J. F. C. Snell, A.M. Inst. Elec. and Mech. E., who was for several years with Messrs. Crompton and Co. at their central stations in England and abroad, and who has been acting lately as electrical inspector to the directors of the Crystal Palace, has been appointed engineer to the Albert Electric Lighting Company, South Kensington.

Mr. T. Cross who was for many years employed in the National Telephone Company, Limited, has been appointed secretary to The National Electric Supply Company, Limited, Preston.

Dundee International Electrical Engineering and Inventions Exhibition.—The Town Clerk at the meeting of the Finance Committee of the Dundee Town Council last week, submitted a report by the liquidator of the International Electrical Engineering and Inventions Exhibition, Edinburgh, calling a meeting of the contributories to be held in Edinburgh, when the report and statement of accounts were to be submitted.

The French Elmore Works.—Dives, where these works are situated in Calvados, forms both a station of the Chemin de Fer de l'Ouest and a small seaport, and a branch line actually runs into the works. The locality is within ready access for supplies of copper and of English coal at low rates. The main buildings, apart from the boiler house, foundry, warehouse, workmen's dwellings, &c., occupy a length of 110 yards and a width of 90 yards. The number of tanks is said to be daily on the increase since the starting of the works on March 1st. The dynamos, which are of the Hillairet and Huguet type, are three in number and furnish 900 electric horse-power. M. Francis Laur, who recently visited the works, speaks highly of them, but he omits to mention, as late as the 3rd inst., the actual output, &c.

St. Pancras Electric Lighting.—The Regent's Park central station is now completed, and a private view of the works in full operation took place last Friday. The chairman of the Electrical Committee of the vestry, the vestry clerk, and a party of visitors, were received by the engineer, Prof. Henry Robinson.

The Lisbon-Azores Cable.—Referring to our note on this subject last week, the following despatch from the Lisbon correspondent of the *Times* was refused transmission by the Portuguese telegraph authorities at Lisbon on March 31st:—"The question of the cables from Lisbon to the Azores and the United States is giving rise to serious comment. It is openly stated that in non-fulfilling the contract signed with the British company the Government have committed a breach of faith, and that their reason for so acting was fear that the French would refuse to raise the loan mentioned in the proposals for the payment of the coupon in two years if they did not succeed in obtaining the contract to lay the cables. Notwithstanding that the Government have repudiated the contract they signed, they still hold out hopes to the British company of coming to an arrangement. I have reason to believe that the company, in order to lose no time and to satisfy the demands of the Azorians, will immediately submit modified terms to the Government and request a prompt solution of the question. The proposals of the French company for laying the cables, which are published in the *Diario do Governo*, do not contain advantageous terms. They are brief and vague, and are only conspicuous for the statement that in treating with them the Portuguese Government will be relieved of the stipulations of Articles 37 and 38 of the contract with the British company prolonging the privileges accorded on March 19th, 1890, to the Eastern Telegraph Company for 10 years. Not only was the contract with the British company signed by the Minister of Public Works, but it was approved by the Parliamentary Committee appointed to report on it, and had not the Government pusillanimously given way to the intervention of the French Government, it would have been immediately voted by the Cortes, as a large majority of the Deputies were desirous of settling the matter at once. I understand that the British Government has been fully informed of the proceedings in this matter."

Electrical Patents in Germany.—During 1891, 567 applications were made to the German patent office in connection with electrical apparatus. Of this number 231 were granted.

NEW COMPANIES REGISTERED.

Madras Electric Tramways Company, Limited.—Capital £100,000, in £1 shares. Objects: To acquire a concession which was granted by the municipal authorities of Madras, by an order bearing date November 18th, 1891, and approved by the Madras Government, for the construction of tramways in Madras; to carry into effect an agreement dated March 16th, 1892, between W. Digby and S. A. Chalk of the one part, and F. W. Fowler (for the company) of the other part; and to carry out the construction of the said tramways, and to work the same with electricity conveyed through overhead or underground wires, animal power, steam, or other mechanical power. Signatories (with 1 share each): W. Digby, 1, Trafalgar Buildings, Northumberland Avenue, S.W.; A. J. Lusty, 70, Gracechurch Street, E.C.; S. A. Chalk, 1, Trafalgar Buildings, Northumberland Avenue, S.W.; A. E. Asser, Suffolk Lodge, Teddington; M. M. Bhownaggree, Tessville Priory Road, Bedford Park; W. A. Gibson, 4, Queen Victoria Street, E.C.; H. E. Eve, 5, Philpot Lane, E.C. The number of directors is not to be less than three nor more than six, the first being W. Digby (chairman), M. M. Bhownaggree, W. A. Gibson, A. J. Lusty, and S. A. Chalk (managing director). Qualification, £250. Remuneration, £100 each per annum, to be increased according to profit. Registered on the 2nd inst. by Paul E. Vanderpump and Eve, solicitors, 5, Philpot Lane, E.C.

Chelmsford Electric Lighting Company, Limited.—Capital, £10,000 in £1 shares (7,500 preferred and 2,500 ordinary). Objects: To enter into a draft contract already prepared in the name of this company, and made with Crompton and Company, Limited, for the purchase and transfer to the company of the Board of Trade licence to supply electricity in the borough of Chelmsford, and to carry on all or any of the business usually carried on by an electric light, heat, and power supply company. Signatories (with 1 share each): J. F. Albright, Arc Works, Chelmsford; C. F. Tufnell, Lloyds, E.C.; H. G. W. Drummond, 7, Ovington Square, S.W., and Messrs. J. Luckin, J. S. Brown, J. G. Bond, and G. Baker, of Chelmsford. The number of directors is not to be less than three nor more than five, the first to be appointed by the subscribers. For the rest, the regulations of Table A mainly apply. Registered on the 30th ult. by E. H. F. Reeves, Little Heath, Potter's Bar.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Kensington and Knightsbridge Electric Lighting Company, Limited.—The annual return of the above-named company, made up to the 24th ult., was filed on the 29th ult. The nominal capital is £350,000, divided into 50,000 ordinary, 10,000 first preference, and 10,000 second preference shares of £5 each. Of these 15,000 ordinary and 10,000 first preference shares have been taken up, of which 5,000 ordinary shares have been issued as fully paid. Upon the remaining shares the full amounts have been called and paid. Registered office, 148, Brompton Road, London, S.W.

Newcastle-upon-Tyne Electric Supply Company, Limited.—The annual return of this company, made up to the 8th February, 1892, was filed on the following day. The company has a nominal capital of £50,000 in £5 shares, of which 5,106 have been taken up, and of these 18 have been issued as fully paid. Upon 4,066 of the remainder £4 per share has been called, and upon the remaining 1,022 shares £3 per share has been called. The calls paid amount to £20,602 (including £1,572 paid in anticipation of calls), and £300 is as yet unpaid. Registered office, Pandon Dene, Newcastle.

Vaughan-Sherrin Electrical Engineering Company, Limited.—The annual return of this company, made up to 14th February, 1892, was filed on the 21st ult. The nominal capital of the company is 25,000, divided into 4,975 ordinary and 25 founders' shares of £5 each. Of these, 4,034 ordinary and the founders' shares have been taken up, of which, 2,487 ordinary and 9 founders' shares have been issued as fully paid. Upon the remaining shares, £4 per share has been called resulting in the payment of £5,766 and leaving £486 unpaid. Registered office, 37, Tabernacle Street, Finsbury, E.C.

Westminster Electric Supply Corporation, Limited.—The annual return of this company, made up to the 9th ult., was filed on the 28th ult. The nominal capital is £300,000 in £5 shares, of which all have been taken up, the full amount called, and all calls paid. Registered office, 2, Victoria Mansions, Victoria Street, Westminster, S.W.

Wrexham and District Electric Supply Company, Limited.—The annual return of this company, made up to the 15th February, 1892, was filed on the same day. The company has a nominal capital of £20,000 in £5 shares of which 115 have been taken up and no calls have been made. Registered office, Yspytty, 12, Queen Street, Wrexham.

Yorkshire House-to-House Electricity Company, Limited.—The annual return of this company, made up to the 11th January, 1892, was filed on the 16th ult. The nominal capital is £100,000 divided into 19,900 ordinary and 100 founders' shares of £5 each. The founders' and seven of the ordinary shares have been taken up, of which the 100 founders' shares were issued as fully paid to the parent company, viz., the House-to-House Electric Supply Company, Limited. Upon the ordinary shares no calls have been made. Registered office, 32, Park Row, Leeds.

City of Bath Electric Light and Engineering Company, Limited.—The first annual return of this company, made up to the 12th ult., was filed on the 19th ult. The nominal capital is £60,000 divided into 5,500 ordinary shares of £10 each and 50 founders' deferred shares of £100 each. At the time of making up, 3,246 ordinary and the 50 founders' shares had been taken up, and of these 2,250 ordinary and all the founders' shares had been issued as fully paid up. Upon the remaining 996 ordinary shares the full amount has been called. The calls paid amount to £9,835, and unpaid to £125. Registered office, Bath Electric Light Works, Dorchester Street, Bath.

Nonpareil Electric Syndicate, Limited.—The annual return of this company, made up to the 31st December last, was filed on the 23rd ult. The nominal capital is £6,000 in £10 shares, of which 400 have been taken up, and 200 issued as fully paid; upon the remaining 200 shares the full amounts have been called and paid. Registered office, 2, Victoria Mansions, Victoria Street, Westminster, S.W.

Bernstein Electric Lamp Company, Limited.—The annual return of this company, made up to the 31st December, 1891, was filed on the 15th ult. The nominal capital is £100,000 in £10 shares, 2,814 of which have been taken up, the full amount called, and all calls paid. Registered office, 40, Chancery Lane, W.C.

Bishops Stortford Electric Light and Steam Laundry Company, Limited.—The annual return of this company, made up to the 26th February, 1891, was filed on the 11th ult. The nominal capital is £10,000 in £1 shares. Of these, 13 have been taken up and no calls have been made. The annual return for 1891, made up to the 26th February, 1892, was also filed on the 11th ult., no change having been made. Registered office, North Street, Bishops Stortford, Herts.

Taunton Electric Lighting Company, Limited.—The annual return of this company, made up to the 14th ult., was filed on the 18th ult. The nominal capital is £20,000 in £5 shares, of which 2,569 have been taken up, and 787 have been issued as fully paid. Upon the remainder, the full amount has been called, and all calls (£8,910) have been paid. Registered office, St. James's Street, Taunton.

Windsor and Eton Electric Light Company, Limited.—The annual return of this company, made up to the 11th ult., was filed on the same day. The nominal capital is £30,000, divided into 5,950 ordinary shares of £5 each, and 250 founders' shares of £1 each. 250 ordinary shares have been taken up, the full amount called, and all calls, with the exception of £58, paid. Registered office, 54, High Street, Windsor, Berks.

Railway Automatic Electric Light Syndicate, Limited.—The annual return of this company made up to February 15th, 1891, was filed on the 11th ult. The

nominal capital is £10,000 in £25 shares, all of which have been taken up and 200 issued as fully paid. Upon the remaining 200 shares, £15 per share has been called, and the calls paid amount to £2,886, leaving £114 unpaid. Registered office, 9, Austin Friars, E.C.

Sunbeam Lamp Company, Limited.—The annual return of this company, made up to the 12th February, 1892, was filed on the 22nd following. The nominal capital is £25,000 in £10 shares, of which 2,213 have been taken up. Of these 2,000 have been issued as fully paid, while upon the remaining 213 shares the full amount has been called, and, with the exception of £30, paid. Registered office, Park House, Gateshead.

Keswick Electric Light Company, Limited.—The annual return of this company, made up to the 12th ult., was filed on the 21st ult. The nominal capital is £5,000 in £1 shares, 3,420 of which have been taken up. Upon 2,355 of these the full amount has been called, while upon the remaining 1,065 shares 10s. per share has been called, resulting in the payment of £2,887 10s. Registered office, St. John Street, Keswick.

Northampton Electric Light and Power Company, Limited.—The annual return of this company, made up to the 10th ult., was filed on the 21st ult. The nominal capital is £50,000, divided into 10 "A" and 49,990 "B" shares of £1 each. Of these, 10 "A" and 10,000 "B" shares have been taken, and the full amount has been called and paid on the "B" shares, while no calls have been made on the "A" shares. Registered office, 2, St. Giles Square, Northampton.

Electrical Accessories Company, Limited. — The annual return of this company, made up to January 14th, 1892, was filed on the 15th ult. The nominal capital is £5,000 in £1 shares, of which 1,957 have been taken up and 1,500 issued as fully paid, upon the remainder the full amount has been called and all calls (£457) have been paid.

Another return, made up to February 15th, 1892, was filed on the 15th ult., when 2,257 shares were taken up, and £757 (an additional £300 on the above return) paid in respect of calls. Registered office, 5, Macclesfield Street, Shaftesbury Avenue, London, W.

City of Westminster Electrical Syndicate, Limited.—The annual return of this company, made up to December 31st, 1891, was filed on the 16th ult. The nominal capital is £20,000 divided into 10,000 ordinary shares of £1 each and 1,000 preference shares of £10 each. All the £1 shares have been taken up, the full amount called, and all calls paid. A note affixed to the return states that "no meeting was held during 1891, the syndicate having been acquired by the Westminster Electrical Supply Corporation, Limited, and it is now in the process of voluntary liquidation." Registered office, 4, Victoria Mansions, 32, Victoria Street, Westminster, S.W.

Telegraph Construction and Maintenance Company, Limited.—The annual return of this company made up to the 15th ult, and filed on the 24th ult, shows that out of a capital of £448,200 divided into 37,350 shares of £12 each, all the shares have been taken up, the full amounts called and all calls paid.

International Electric Subway Company, Limited.—The registered offices of the above-named company, have been removed from 43, Threadneedle Street, E.C., and are now situate at Albany Chambers, 39, Victoria Street, Westminster, S.W. (filed on the 5th ult.).

New Telephone Company, Limited.—At an extraordinary general meeting of the above-named company, held at 147, New Bond Street, W., on January 26th, 1892, the following special resolution was duly passed, and at a subsequent extraordinary general meeting, held at 3, Carlton House Terrace, S.W., on the 16th ult., the same resolution was duly confirmed:—"That the Bill submitted to the meeting, entitled 'A Bill to provide for dissolving the New Telephone Company, and for re-incorporating the company and defining its capital, objects and powers,' be and the same is hereby approved, subject to such additions, alterations or variations as Parliament may think fit to make and the directors shall sanction" (filed on the 22nd ult.). Registered office, 90, Cannon Street, E.C.

Orient Electric Lighting Company, Limited.—The annual return of this Company, made up to December 31st, 1891, was filed on the 16th inst. The nominal capital is £5,000 in £250 shares, of which 13 have been taken up, a call of £100 per share made and all calls paid. Registered office, 2, East India Avenue, Leadenhall Street, E.C.

Mexican Gas and Electric Light Company, Limited.—The annual return of this company, made up to December 23rd, 1891, was filed on the 9th ult. The nominal capital is £100,000, in £20 shares, all of which have been issued as fully paid. Mr. A. G. H. Gibbs, of 15, Bishopsgate Street Within, E.C., holds 4,994 shares. Registered Office, 15, Bishopsgate Street Within, E.C.

Northern Electric Wire and Cable Co., Limited.—The annual return of this company, made up to the 24th ult., was filed on the 8th ult. The nominal capital is £20,000, in £5 shares (of which 660 are vendors and 3,340 ordinary shares). Of these, all the vendors and 1,512 ordinary shares have been taken up, and the vendors' shares have been issued as fully paid. Upon the ordinary shares £2 10s. per share has been called, and all calls with the exception of £2 10s. have been paid, amounting to £3,777 10s. Registered Office, Square Road, Halifax.

Laurence Scott and Company, Limited.—The annual return of this company, made up to January 6th, 1892, was filed on the 7th ult. The nominal capital is £30,000 in £10 shares, of which 1,205 have been taken up. Of these, 300 have been issued as fully paid, and upon the remainder the full amount has been called, and all calls (9,050) paid. Registered office, Gothic Works, King Street, Norwich.

Portland Electric Light Company, Limited.—The annual return of this company, made up to January 14th, 1892, was filed on January 21st, 1892. The nominal capital is £45,000, in £5 shares, of which seven have been taken up, the full amount called, and all calls paid. Registered office, 48, Osnaburgh Street, N.W.

PARLIAMENTARY NOTES.

The Postal Telegraph Factory.

In the House of Commons last Monday, in answer to Mr. Buxton,

Sir J. Fergusson said: The hours of work at the postal telegraph factory are uniform for the tradesmen employed, and not varying according to those worked elsewhere by those of similar trades in different circumstances. I am not aware that carpenters belonging to Unions have been thereby debarred from seeking work at the factory, and no complaints on the subject have been received. The men referred to are believed to have been two of three who were parted with on the completion of a piece of work connected with the extra pressure at Christmas. Their discharge was not connected with the question of shorter hours. Having regard to the privileges of a fortnight's leave on full pay and of an extra day at Christmas which the carpenters in the factory enjoy in common with the other people there, their pay amounts to more than they would receive under the union pay rules, while the employment is steady and continuous. I believe that the circumstances of employment by the Board of Works differ from those in the Post Office factory.

Telegraphic Extension Guarantees.

In the House of Commons on Tuesday,

Mr. Sherburn asked the Postmaster-General when he expected to introduce the Bill for extending to Scotland the provisions of an Act, now in force in England, whereby local authorities might assess for the purpose of meeting any deficiency arising out of guarantees given to the Post Office in connection with telegraph extension in rural districts.

Sir J. Fergusson: Instructions have been given for the draft of a Bill for this purpose, and I hope shortly to be able to introduce it.

The Signal Light on the House of Commons.

In answer to Mr. J. O'Connor,

Mr. Plunket said: This is the first complaint that I have heard of the insufficiency of the signal light on the Clock Tower, and I believe that in ordinary conditions of the atmosphere the light is well seen in those parts of the town to which it is at present directed. There are times when London fogs are very dense, at which neither this light nor any other can be of much service to any one. If I were satisfied that any considerable number of members of Parliament are now deprived of the advantage of seeing the light, or of the sometimes keener pleasure of seeing it extinguished, that would be a reason, if the expense were not thought too heavy by the Treasury, for endeavouring to spread the light more widely. As to whether this could best be done by gas or by electricity, that is a question on which I believe a good deal may be said on both sides.

BUSINESS NOTICES, &c.

The Electric Light in the St. Pancras District.—Since our last visit to this district we find that the number of installations (current for which is supplied by the central station recently opened) has been increased. The electric light is being fitted in the extension to the Bedford Head Hotel, Tottenham Court Road, which is about completed, by Messrs. Vaughan & Brown, of Kirby Street, E.C. The millinery establishment of Madame Louise, at 100, Tottenham Court Road, is being fitted by the Electric Power and Traction Company, of Kentish Town. This company, which has carried out quite a number of installations, in this district is also fitting up an installation at Hyams Brothers, Tottenham Distillery, 101, Tottenham Court Road. The premises of Messrs. T. W. Thompson & Co., general drapers, of Tottenham Court Road, by Mr. Henry Conolly, of 42, Hampstead Road. Messrs. Siemens Bros. & Co., of Westminster, are fitting up an installation in the premises of the "Capital and Labour" Clothing Association, Tottenham Court Road. Messrs. Rashleigh Phipps and Dawson, of Berners Street, W, are fitting up an installation in their works at Stanhope Street, Euston Road, while the dairy and confectionary establishment of Mr. C. Simpson, situated at the corner of Euston Road and Osnaburgh Place, are being fitted up by Messrs. Ewart & Son, of Euston Road.

Electrical Art Fittings.—A new departure in the field of art applied to electric incandescent lamp fittings has been introduced by Messrs. John Davis & Son, of 118, Newgate Street, London. The electroliers, wall brackets, table lamps, cornice sprays, &c., are composed of floral decorations in *natural* tints. The flowers and foliage being artistically enamelled upon metal, the combination of subjects and colours being extremely effective, and due to the character of the enamelled work, possess an important feature in regard to resistance against oxidation and wear and tear. The designs, of which there are many hundreds, vie with each other in elegance and artistic merit. These fittings are admirably adapted for drawing and dining rooms, theatres, &c.

Tenders Wanted.—Chiswick.—The Chiswick Local Board are prepared to receive tenders from electric lighting companies or persons for the transfer or lease of the Chiswick Electric Lighting Order, 1891, for supply of electric lighting in Chiswick, in the county of Middlesex, and for carrying out the duties and obligations of the Board under such order, for a term not exceeding 21 years. Copies of the provisional order may be seen and any further particulars obtained on application to Mr. Ramsden, Vestry Hall, Turnham Green, by appointment. Sealed tenders to be delivered to the Chairman at a meeting of the Board to be held on May 4th, at 8 p.m., Vestry Hall, Turnham Green.

Tenders Wanted.—Leeds.—Tenders are invited for supplying and fixing electric lighting plant in private houses, by Mr. W. H. Baxter, 71, Geldherd Road, Leeds.

Electric Lighting of Adelaide.—Referring to our remarks last November regarding the tenders invited by the Corporation of the City of Adelaide, we have now full information on the matter in our possession, and any of our readers who are interested in the subject can see a copy of the specification on application at the offices of the Electrical Review.

Personal.—We understand that Messrs. Poole and White, Limited, 58 and 59, Bread Steeet, E.C., have now opened a branch office at 27, Arcade Chambers, St. Mary's Gate, Manchester, under the management of Mr. T. A. Nunwick, their representative for the North of England.

Change of Address.—Owing to increase in business, which has necessitated enlarged office accommodation, Messrs. Wheatley Kirk, Price and Goulty have removed to Albert Buildings, 49, Queen Victoria Street, E.C.

The General Electric Power and Traction Company—We understand that Mr. Robert Macpherson, late general manager of the company, has resigned his position.

CITY NOTES.

House-to-House Electric Light Supply Company.

The fourth ordinary general meeting of this Company was held at the central station, Richmond Road, Kensington, on Tuesday afternoon, the chairman, Mr. Henry Ramié Beeton, presiding.

The Secretary (Mr. H. St. John Winkworth) having read the notice convening the meeting,

The Chairman said: I assume that in accordance with our practice on previous occasions it is the wish of the meeting that the report and accounts be taken as read. That report and those accounts set out the main facts of the progress of the Company for the year 1891, and I think that the shareholders will probably agree with me that the result is at any rate comparatively satisfactory. From the accounts it is seen that the capital expenditure for the 12 months has amounted to £8,996. The increase in revenue has amounted to upwards of £3,300, which has been earned on a percentage of about 41, thereby reducing the percentage of expenses from 92 to 79. Now the profits would, of course, have been larger if the rate of progress during the year had been equal to that of the preceding year. Unfortunately that has not been quite maintained. I find that on December 31st 1889, there were connected to the company's mains 4,520 35-watt lamps, and on December 31st, 1890, 13,665 similar lamps, showing an increase during the year of 9,145. On December 31st, 1891, there were connected to the company's mains 19,388 35-watt lamps, showing an increase during the year of 5,723. Since the close of the year 871 lamps have been connected, raising the total connected on March 31st to 20,259, and there is every indication from the orders in hand and the general development of the district, that we shall have a satisfactory increase during the current year. The company has, of course, benefited by the administrative economies to which I referred at the last general meeting as on the point of being introduced, and, in addition, it has benefited by improvements in the works which have been introduced as the result of greater experience and more perfect organisation. Now, the condition of things which these facts disclose will, I think, justify the assumption that any future increments of capital are likely to be employed at a high rate of productivity, and that after the claims of any new capital have been satisfied, a surplus will be left which will accrue to the ordinary shareholders. At our last general meeting, I was able to announce to the shareholders that the negotiations which had been for some time on foot for the benefiting of our construction asset were on the point of conclusion. Although their consummation was delayed longer than I expected at the time, I am pleased to say that after protracted negotiation, we have at length attained a participation in a contract with the Leeds and London Electrical Engineering Company, whereby, although this company will not enjoy a large share of the profits of that undertaking, on the other hand, it will not be called upon to provide any funds, or take any further risk. Moreover, we are guaranteed £525 a year for the first two years, and if the business is as successful as it promises to be, we may get more than this for many years. With these few observations, I beg to move that the report and accounts be adopted.

Mr. Robert Hammond, managing director, had great pleasure in rising to second the resolution. There was little to add to the chairman's extremely lucid exposition of the present position of the company's business. He thought, however, shareholders would be interested to know that the rate of increase during the year would have been much larger if the plant had permitted the engineers to taken on more business. They had been somewhat limited during the year by their plant, and the active canvassing for business which went on in the previous year was not continued in 1891, so that they might very fairly say that in the coming year, when further plant would be added to that at present in the station, they would have a considerable number of lights added to their circuit. In connection with this, he would also venture to draw the attention of shareholders to the fact, which was not emphasised from the chair, that since those accounts were closed an amount of preference capital had been issued and very freely taken up. The amount was £12,290, which would be spent in the works and used in increasing their possible output. The chairman was, he thought, fully justified in what he said with regard to the good prospects that laid before the company. The profits that had been made during the past year had been made upon a load that had gradually increased. The speaker then called the attention of the meeting to a diagram on the walls, on which curves were drawn showing the increase in the load. In June, 1890, it rose from 8,000 lamps to 20,000 at the end of March, 1892. The maximum output in 1890 was shown to be 210 kilowatts, and this year 264 kilowatts. He was sure directors were not taking too sanguine a view of the future when they said that a point had been reached in the company's history when they had got on a dividend-paying basis. He would congratulate the shareholders on the present position of the company, and would thank the manager and staff, as well as the director who had specially devoted himself to the works, for this condition of affairs. As to the interest that the House-to-House Company had in the Leeds and London Electrical Engineering Company, it might be known to most of them that the latter company was formed for the purpose of dealing efficiently with the so-called construction asset of the House-to-House Company, it being felt that it would be more to the interest of that company to devote all its energies to the supply of electricity from house to house, and to leave to another company that might be able to manufacture machinery the erection of central stations for others. He was very glad indeed to say that though that agreement was only finally made on the last day of last year, the Leeds and London Company, of which he was a director, had met with very great encouragement. He would draw their attention to a notice which appeared in a Midland paper on the previous day, to the effect that at the meeting of the Burton-on-Trent Corporation on Wednesday (April 6th) the Electrical Committee intended to recommend that the contract for the erection of the central station for Burton should be given to that particular firm which was working on behalf of the Leeds and London Company, with the result that the profits thereby accruing would come into the pockets of that company. As the House-to-House Company had a very early charge upon those profits, the fact that that work had been taken would make them hope that the £525 alluded to by the chairman would certainly this year be £1,050, if not more. He was also glad to inform shareholders that the Yorkshire House-to-House Company, which was one that also brought grist to the mill of the Leeds and London Company, had had a very satisfactory amount of capital subscribed, and would, he thought, result in a very good profit to that company, with which they were practically in affiliation. In conclusion, he could only say, as he had said so often, that an electric light company which did its work as well as the House-to-House did might depend upon a gradually increasing business. Those companies which had failed in the race were those that had not been

able to satisfy their customers by giving a good light at a regular pressure. Those who moved about London and had an opportunity of comparing the light given by the House-to-House Company with that given by other companies, would agree with that board in saying that there was no electric light company in the metropolis which was so satisfactorily fulfilling its obligations to its consumers as the House-to-House. Though in a position to hear complaints, he was glad to tell the shareholders that he only heard praises of their lights on every side.

Mr. KIMBER asked how it was that in one account their capital was stated as being £41,610, and in another £26,610. He also called attention to one or two mistakes in the accounts which, he concluded, were misprints; and the chairman said that was so.

Mr. HAMMOND explained that, under the Board of Trade rules, they had to keep two capital accounts, one relating to the House-to House Electric Light Supply Order, 1889, and the other referring to the company's capital.

The CHAIRMAN then put the resolution adopting the report and account, and declared it carried.

On the motion of the CHAIRMAN, seconded by Mr. DAVIES, a dividend at the rate of 7 per cent. on the preference shares was declared.

Mr. HAMMOND moved the re-election of H. R. Beeton as a director, this was seconded by Mr. PAGE, and carried.

The CHAIRMAN then proposed the re-election of Mr. Robert Hammond as a director, Mr. LEESE seconded, and this was carried.

Mr. W. F. Leese and Mr. William Reginald Davies were then elected to the Board. Mr. Leese and Mr. Galindez were elected directors by the Board during the past year, but the CHAIRMAN explained that the latter had been obliged to go abroad, where he was likely to remain for some time, and under the circumstances did not offer himself for re-election.

The auditors (Messrs. Theobald Bros. and Miall) having been re-elected auditors on the proposition of Mr. KIMBER, seconded by Mr. WHITEHEAD, the proceedings closed with a vote of thanks to the chairman.

The Notting Hill Electric Lighting Company, Limited.

THE fifth ordinary general meeting of this company was held on Thursday last week at Winchester House, Old Broad Street, E.C., Prof. Crookes, F.R.S., presiding.

The SECRETARY having read the notice convening the meeting,

The CHAIRMAN said that, with the permission of the shareholders, they would take the directors' report and accounts as read, as they had been in their possession for some time. It was unnecessary for him to say much about the present position of the company, as that was so fully gone into in the report and accounts. There were, however, one or two points to which he wished to draw their attention. In 1890 they subscribed about £70,000 to be used in lighting their district by electricity, and to the directors was entrusted the very responsible task of spending that money in the best possible manner. They had now spent the money in the way it was intended to be spent, in the purchasing of a site for the central station, in erecting on it substantial buildings and powerful machinery, in laying miles of culverts, copper mains and cables, and in getting together a thoroughly efficient staff. Regarding their position, he thought they must all exercise a little patience, for neither in agriculture or electric lighting would the crop follow immediately after the seed had been sown. Like the gas and water companies, they must provide for the probable maximum demand for several years to come, as it would not be tolerated that the streets should be constantly broken up as the demand increased. Turning to the accounts, the chairman referred briefly to the capital and revenue items. He referred with satisfaction to the working of the company, and to the fact that within a year of their opening, they would have 92 houses and 7,052 lamps on their mains, not including the houses and lamps in the Phillimore district, into which they proposed to extend their mains southward. The company had constructed and laid 5½ miles of culvert and pipes, involving the use of 66 tons of copper strips and cable, costing £26,794. The mains ran past 445 houses, which could be supplied practically without further outlay, and were opposite 331 additional houses, which could be supplied by crossing the roads. The number of lights already supplied was equivalent to 6,056 8-candle-power lamps, and the company had orders in hand for 560 more. Having given some statistics to show the progress of the Kensington and Knightsbridge Company, he inferred, without venturing to prophesy, that the Notting Hill Company would be next year, if the demand for the electric light continued as at present, in a thoroughly sound and prosperous condition. The fixed machinery had cost £7,965, and the works, as they now stood, could supply installations aggregating 21,000 lamps, reckoning as usual that one-third only of these would be simultaneously in use. They had contracted for an extension of their mains into the Phillimore district, where they expected large orders. He concluded by moving the adoption of the report and accounts.

The motion was seconded by Mr. FRANKLIN, and carried unanimously.

Professor CROOKS moved that the retiring directors, *i.e.*, Messrs. F. Radford and A. E. Franklin, be re-elected directors of the company.

Mr. JARVIS seconded, and it was carried.

The auditors, Messrs. Deloitte, Dever, Griffiths & Co., were re-elected, at a remuneration of 30 guineas.

An extraordinary general meeting was then held, at which the following resolutions, moved by the CHAIRMAN, and seconded by Mr. WALTERS, were unanimously agreed to.

"That the remaining 2,998 shares still unissued of the 10,000 shares in the company, or such less number as the directors may determine, be issued, and as between such shares and the other ordinary shares issued, or to be issued, such shares shall be preference shares, and issued under the title of ordinary preference shares.

"That the ordinary preference shares be entitled to receive out of the sums for the time being applicable for the payment of dividend or bonus on ordinary shares, a dividend at the rate of six per cent. per annum before any payment by way of dividend or bonus be made to the rest of the ordinary shares already issued or to be issued, and that the right of the ordinary preference shares to preferential dividend as aforesaid, be cumulative, so that the deficiency (if any) of one year to pay such preferential dividend, be made up out of the sums applicable for dividend or bonus on ordinary shares in any succeeding year or years, before any payment, as aforesaid, be made to the rest of the ordinary shares.

"That after and in addition to the payment of such preferential dividend of six per cent. per annum, including arrears (if any) of dividend from previous years, the ordinary preference shares shall also be entitled, but not until the holders of the rest of the ordinary shares shall have been paid a dividend for the year at the rate of six per cent. per annum, to participate with the rest of the ordinary shares *pari passu*, and without distinction in dividend or bonus available for division over and above such six per cent. per annum payable to the holders of the rest of the ordinary shares.

"That in case of any return of capital in respect of ordinary shares, or of winding-up, the holding of such ordinary preference shares shall not entitle the holders thereof to any preference in the return of capital, or in the distribution of assets, but in respect thereto the ordinary preference shares shall rank as ordinary shares.

"That the time, conditions, and extent of the said issue of ordinary preference shares be left to the board to regulate, determine, and carry out.

"That the preferential rights in respect of the holding of the ordinary preference shares are only to be as between such shares and the rest of the ordinary shares, and shall not under any circumstances affect, prejudice, postpone, or abridge the rights under the articles of association of the holders of the founders' shares."

A vote of thanks to the chairman having been acknowledged, the proceedings terminated.

The Maxim-Weston Electric Company, Limited.

THE NEW COMPANY.

THE liquidators of the new company—Messrs. John Marks and James Hodgson — have convened a meeting of the members to be held to-day at the Cannon Street Hotel, "in order that there may be laid before the said company an account showing the manner in which the winding up has been conducted, and the property of the company has been disposed of, and in order that the said company may hear any explanation that may be given to the liquidators; and also in order that an extraordinary resolution may be passed for determining the manner in which the books, accounts and documents of the said company, and of the liquidators, shall be disposed of, and to vote the liquidators' remuneration."

The following is the report which will be submitted to the meeting:—

"The liquidators are pleased to be able to announce that the tedious process of liquidating the above company is now concluded, and they beg to submit an account showing the result of the winding up. The heavy litigation in which the old company was involved sufficiently explains the delay in winding up the present company. The liquidators regret that the assets of the company produced a comparatively small amount when realised, but they wish to point out that they have been successful in limiting the expenses of realisation to a really nominal amount. The balance in hand will be distributed subject to liquidators' remuneration and expenses, amongst the shareholders, in proportion to the number of shares held by each."

The accounts, extending from August, 1890, to April, 1892, shows "cash in hand £1,249 14s. 6d.," and a note is appended to the effect that "in addition to the balance in hand on this account there will be a balance to receive from the liquidators of the old company and interest on deposit accounts."

THE OLD COMPANY.

A meeting of the members of this company has also been convened, to be held at the same time and place as above stated, when the following report of the liquidators—Messrs. John Marks and Louis Swaby—will be submitted:—

"In submitting the accounts on the closing of this liquidation to the members of the above company, the liquidators beg to make the following observations:—

"The liquidators, through whom the transfer of the company's property was to be effected, found it necessary to themselves get in part of the assets and discharge some of the liabilities of the company. The other assets of the company were received by the new company, by whom, also, the remaining liabilities of the old company, and certain liabilities incurred by the liquidators, were discharged in the terms of the reconstruction agreement.

"At the date of the appointment of the liquidators, heavy litigation was pending on the subject of a large proportion of the company's affairs.

"The claims by and against the company were, with the approval of the directors of the new company, settled, with the exception of the Watt litigation and the claims by and against Palmer's Shipbuilding Company and the Brighton Corporation.

"In Mr. Watt's action against the company a heavy claim was made by him. In the other two cases heavy damages were claimed against the company, and the liquidators, after unsuccessful attempts on their part to satisfactorily settle, had no option but to contest them.

"It will be within the recollection of the shareholders that it was unanimously resolved in general meeting that the claims by and against Mr. Watt should be resisted and prosecuted by the liquidators with vigour.

"Mr. Watt's claims for upward of £1,700 and damages were successfully resisted, and the liquidators recovered against him £1,000, together with costs in both actions. The company was also successful in the reference to arbitration as to the number of shares to which Mr. Watt was entitled.

"The liquidators recovered in their proceedings against the Brighton Corporation; but the arbitrator awarded the Corporation damages exceeding by £7 odd the amount recovered by the liquidators, and directed the company to pay all the costs.

"In the case of the Palmer's Shipbuilding Company, the official referee ordered a return of the plant to the company, and awarded Palmer's Company damages for an inefficient installation, and all the costs. This litigation was instituted so far back as March, 1888.

"The liquidators would point out that in consequence of the state of the company's affairs they incurred a very heavy personal liability in carrying on the litigation with Mr. Watt.

"The balance of £414 16s. 3d. in hand, subject to the liquidators' remuneration, will be handed to the liquidators of the new company."

International Electric Subway Company, Limited.

THE ordinary general (statutory) meeting of the International Electric Subway Company, Limited, was held on Thursday, week before last, at 12, King William Street, E.C., Mr. John L. Martin presiding.

The secretary (Mr. Theodore J. Ford) read the notice convening the meeting.

The CHAIRMAN said: Gentlemen, as you are doubtless aware, we are assembled at this statutory meeting of our company in accordance with law, which requires that we should hold a meeting within four months of the date of our registration. We can hardly be expected to have anything very definite to submit to you at this time, but, with your permission, I will give some facts which may interest you in regard to what we have done and propose doing. In the first place, under the advice of our solicitors, we have completed the purchase of all the patents for the United Kingdom and Europe of the Johnstone system of underground electrical conduits. As you may know, this system is extensively used in the United States, several hundred miles of the conduits being laid in New York, Chicago, and Philadelphia, and large contracts are we understand, now being carried out in other of the principal cities of America. The system has been so extensively adopted in America, because of its economy and permanency, that I do not think it is an exaggeration to say that it is the standard system of electrical conduits in use in America to-day. As you may see by the pamphlets which have been distributed, and by reports in the English scientific papers, our system is one by which wires are laid in rectangular iron boxes with interior sub-divisions. The upper part of this conduit, as also the lower part, is made in sections of 5 ft., so arranged as to break joints at any point where it may be necessary. The wires in the conduits can be made easily accessible without disturbing them or pulling them through long lengths of pipe, and this can be done by simply lifting off the top piece at any point desired. In addition, the man-holes and connections can be put in at any point desired at small cost. The whole of the conduit is made of cast iron, and we are prepared to take contracts and lay our system for the same money as any other system now in use; and we also claim that we will give for the money very much better results in the way of permanency, safety, and facility of handling and operation. Our energetic managing director has secured the attendance at our offices of many engineers interested in electrical subway conduits from various parts of England, and has explained our system to them, with the result that we believe we are on the eve of obtaining large and substantial orders in various of the principal towns in England, and even within the precincts of London itself, and also in Paris. We have placed a full-sized model of our system in the Crystal Palace, where, we understand, it is exciting considerable interest. I shall be glad to answer any questions that may be put, and our managing director will be glad at any time to show our system, and explain in detail our method of operation, to any of the stockholders who care to call at our offices and showrooms in Albany Buildings, 39, Victoria Street, Westminster. It should be borne in mind that our company is really a pioneer syndicate, with a capital of only £25,000, and, as our system becomes more widely known, the directors believe they will be able to dispose of your rights on very favourable terms to the various European countries.

Mr. T. G. BEEMAN proposed a vote of thanks to the chairman, and said that he considered the information given to the shareholders was, so far, satisfactory.

Mr. FORD seconded the proposition, which was carried unanimously.

An extraordinary general meeting was afterwards held, when the directors' remuneration was fixed at £250 per annum.

The Telephone Company of Egypt, Limited.

THE directors' report for the year ending December 31st, 1891, which was presented at the ninth ordinary general meeting of the company, held at the offices of the company, 14, Austin Friars, E.C., on Tuesday last, states that the revenue account shows a balance to credit of £4,053 16s. 1d., after payment of debenture interest; adding to this the sum of £1,508 5s. 5d., brought forward from December 31st, 1890, there remains a balance for disposal of £5,562 1s. 6d., which the directors propose to deal with as follows:—To pay a dividend of 6 per cent. on the preferred shares, free of income tax, to transfer £525 18s. 6d. in reduction of capital expenditure, and to carry forward £1,414 17s. A small exchange was opened at Suez on July 14th, communicating with Port Thewfick, and although the demand for telephonic service must at these places necessarily be restricted, the directors are desirous of meeting the public wants in the matter of telephonic communication so far as lies in their power. The support that has been given is sufficient to pay expenses in the meantime, but an extension of the system is hoped for. At Mansourah, although the terms of subscription were fixed as low as possible, many of the original subscribers had from time to time withdrawn, the demand for telephone inter-communication having been found very limited. Under advice of the company's manager, the "exchange" service has now been discontinued, but arrangements are in progress with several firms for the rental of some of the existing lines for private use. On the whole, considering the wave of commercial depression that has passed over the country, the result of the year's business is not unsatisfactory. The profits realised from the sales of material, &c., have more than made up for the falling off of revenue at one or two of the smaller branches, and from the accounts now published some doubtful subscriptions have also been excluded. The gross revenue of the company at December 31st, was £11,263, and the total number of lines, exchange and private, 1,041. The retiring director at the present meeting is the chairman, General Alexander Fraser, C.B., R.E., who, being eligible, offers himself for re-election. Messrs. Price, Waterhouse & Co, the auditors of the company, also retire, and offer themselves for re-election.

At the meeting, General Alexander Fraser, C.B., R.E., presided.

The CHAIRMAN, in moving the adoption of the report, said he had little to add beyond what was contained in the report. The business generally had been going on in the same even course as it had previously done, and the board was enabled to propose a dividend of 6 per cent. on the preferred shares. He did not suppose they would expect the business to improve by leaps and bounds, but they might hope with the efficient staff they had in Egypt that they might have an annual increase of subscribers. It was true this increase was sometimes discounted by the demand for lower rates, but this was a demand they were forced to resist, as they thought the rates were as low as was consistent with an efficient service. That the service was efficient he thought they might judge from the absence of all complaints. Mr. Evans, their manager, in Egypt was a very good officer, and his accounts came over in good order, while the supervision of Mr. Chalmers, the secretary, and his able staff kept the cost of the service at the lowest point possible.

Mr. THOMAS LLOYD seconded the adoption of the report, which was carried, and after the re-election of the retiring directors and auditors, votes of thanks were accorded to the manager and staff, and to the chairman. The proceedings then terminated.

W. T. Henley's Telegraph Works.—Warrants were posted on the 1st inst. for a dividend at the rate of 7 per cent. per annum on the preference shares, and of 5 per cent. per annum (free of income tax) on the ordinary shares for the year ended December 31st, 1891. The subscribed share capital of this company is £21,000 preference shares and £67,270 ordinary shares.

Elmore's American and Canadian Copper Company.—The fully-paid share certificates of Elmore's American and Canadian Patent Copper Depositing Company are ready to be exchanged for allotment letters and banker's receipts, which should be forwarded to the offices of the company forthwith.

Eastern Extension Telegraph Company, Limited.—A further dividend of 2s. 6d. per share is proposed by the directors, together with a bonus of 4s. per share, making a total distrbution for 1891 of 7 per cent. The balance of £111,987 has been carried to the reserve fund.

Telephone Company of Austria.—The dividend on the preference shares at the full rate of 6 per cent. per annum is announced for the past half-year.

Globe Telegraph and Trust.—An interim dividend of 2s. 6d. per share has been declared by the directors, payable on the 20th inst.

TRAFFIC RECEIPTS.

The Cuba Submarine Telegraph Company, Limited. The receipts for the month of March were £4,000 as compared with £4,002 in the corresponding month of last year.

Direct Spanish Telegraph Company, Limited. The estimated traffic receipts for the month of March, 1892, were £2,103, as against £1,930 in the corresponding period of last year.

The Eastern Extension, Australasia, and China Telegraph Company, Limited. The traffic receipts for the month of March, 1892, were £43,805, and £44,716 in the corresponding period of 1891.

The Eastern Telegraph Company, Limited. The traffic receipts for the month of March, 1892, were £59,087, and £58,447 for the same period of 1891.

The Great Northern Telegraph Company. Receipts in March, 1892, £22,000; 1st January—31st March, 1892, £62,800: corresponding months, 1891, £64,400; corresponding months 1890, £60,200.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending April 1st, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, amounted to £3,265.

The West India and Panama Telegraph Company. The receipts for the week ending March 31st, showed a decrease of £359 as compared with the corresponding period.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation, March 31st.	Closing Quotation, April 7th.	Business done during week ending April 7th, 1892. Highest.	Lowest.
250,000£	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	100 — 103	100 —103	...	...
1,300,980£	Anglo-American Telegraph, Limited	Stock	49½ — 50½	49½ — 50½	...	...
2,849,510£	Do. do. 6 p. c. Preferred	Stock	88½ — 89½	88½ — 89½	89¼	88¾
2,849,510£	Do. do. Deferred	Stock	11½ — 12	11½ — 11¾	11⅝	11½
130,000	Brazilian Submarine Telegraph, Limited	10	10¾ — 11¼xd	10¾ — 11¼xd	11¼	11
53,200£	Do. do. 5 p. c. Bonds	100	100 —103	100 —103	...	...
75,000£	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	104 —108	104 —108	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	3⅛ — 3⅜	3 — 3¼	3¼	3 1/16
69,996	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2⅛ — 2⅜	2 — 2¼	2 5/16	2¼
40,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	3½ — 4½	3½ — 4½	...	...
50,000	City and South London Railway, Nos. 1 to 50,000	10	2½ — 3⅛	2½ — 3⅛	3⅛	2⅞
30,152	City of London Elec. Lighting Co., Ltd., Ord. 40,001-70,152, £4 paid	10	7½ — 8	7½ — 8	...	...
$7,716,000	Commercial Cable, Capital Stock	$100	155 —160	155 —160	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ..	14/-	⅜ — ½	⅜ — ½	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	5½ — 6	5½ — 5⅝	...	...
16,000	Cuba Telegraph, Limited	10	10½ — 11½	10½ — 11½	11 1/16	...
6,000	Do. do. 10 p. c. Preference	10	16½ — 17½	16½ — 17½	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3¼ — 3⅜xd	3¼ — 3⅜xd	...	...
6,000	Do. do. 10 p. c. Preference	5	8½ — 9¼xd	8½ — 9¼xd	9¼	...
60,710	Direct United States Cable, Limited, 1877	20	11½ — 11⅝	11½ — 11½	11½	11¼
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14¾ — 15	14¾ — 15	15	14 13/16
70,000	Do. 6 p. c. Preference	10	15 — 15½	15½ — 15⅝	15½	15½
200,000£	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	106 —109	106 —109	108	107½
1,200,000£	Do. 4 p. c. Mortgage Debenture Stock	Stock	108 — 111	109 —112	111	109¼
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	14⅞ — 15⅛	14⅞ — 15⅛	15⅛	14 13/16
78,300£	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	102 —105	102 —105	104½	...
276,200£	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	102 —105	102 —105	...	...
320,000£	Do. 4 p. c. Debenture Stock	Stock	106 —109	107 —110	109	108¼
135,000£	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	101 —104	101 —104	...	...
180,400£	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	102 —105	102 —105	102¾	...
201,600£	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	99 —102	99 —102	101½	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	5¾ — 6¼	5¾ — 6¼	6⅛	5 15/16
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	1⅜ — 1⅝	1⅜ — 1⅝	1⅝	1 7/16
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	2½ — 2¾	2⅝ — 2¾	2 13/16	2 11/16
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	1⅝ — 1⅞	1½ — 1¾	1½	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	10 — 10½	10 — 10½	10½	10
180,042	Do. do. 6 p. c. Preference	10	15 — 15½	15 — 15½	15½	15
150,000	Great Northern Tel. Company of Copenhagen	10	18⅜ — 19½	18⅜ — 19½	19	...
220,000£	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	105 —108	105 —108	...	...
12,134£	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	7¾ — 8¼	7¾ — 8¼	...	...
9,600£	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	9½ — 10½	9½ — 10½	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	20 — 21	20 — 21	20½	20
200,000£	Do. do. 4½ p. c., Deb., 1896	100	102 —105	102 —105	103¾	...
17,000	Indo-European Telegraph, Limited	25	41 — 43	41 — 43	42½	42
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	4 — 5	4 — 5	4⅝	4½
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	8 — 9	8 — 9	...	...
30,000	†Liverpool Electric Supply, £3 paid	5	2⅞ — 3	2⅞ — 3	2⅞	2⅝
10,000	Do. do. fully paid	5	5 — 5⅛	5 — 5⅛	5 1/16	4⅞
38,348	London Platino-Brasilian Telegraph, Limited	10	6 — 7	6 — 7	...	...
100,000£	Do. do. do. 6 p. c. Debentures	100	106 —109	106 —109	...	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	8¼ — 9	8¼ — 8¾	8⅝	8⅜
447,234	National Telephone, Limited, Nos. 1. to 438,984	5	4⅜ — 4⅝	4⅜ — 4⅝	4 9/16	4⅜
15,000	Do. 6 p. c. Cum., 1st Preference	10	12½ — 13½	12½ — 13½	...	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	11½ — 12½	11½ — 12½	12½	12 1/16
420,000£	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	105 —107	106 —108	107½	106½
250,000£	Do. (issued at 5 p.m., all paid)	...	79 — 81	79 — 81	...	...
6,318	Notting Hill Electric Lighting Company, Limited, £8 paid ...	10	3½ — 4½	4 — 4½	3⅞	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	¼ — ⅜	¼ — ⅜	...	...
9,000	Reuter's Limited	8	7½ — 8	7 — 8	7	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	8 — 8½	8¼ — 8¾	8⅜	...
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	7¼ — 7½	7½ — 8	7 11/16	7⅝
3,381	Submarine Cables Trust	Cert.	116 —121	116 —121	...	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	4 — 4⅛	3¾ — 4¼	4	...
37,350	Telegraph Construction and Maintenance, Limited	12	42 — 44	42 — 44	44	42½
150,000£	Do. do. do. 5 p. c. Bonds, red. 1894	100	101 —104	101 —104	...	...
58,000	United River Plate Telephone, Limited	5	2 — 3	2 — 3	...	...
146,370£	Do. do. 5 p. c. Debenture Stock ...	Stock	85 — 95	85 — 95	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	7 — 8	7 — 8	...	...
271,400£	Do. do. do. 5 p. c. Debentures	100	99 —102	99 —102	100⅝	...
30,000	West Coast of America Telegraph, Limited	10	3½ — 4½	3½ — 4½	...	...
150,000£	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	102 —106	102 — 106	...	...
67,007	Western and Brazilian Telegraph, Limited	15	10 — 10½	10 — 10½	10⅛	...
30,364	Do. do. do. 5 p. c. Cum. Preferred	7½	6 — 6½	6 — 6½	6⅝	6¼
30,364	Do. do. do. 5 p. c. Deferred	7½	4 — 4½	4 — 4½	4¼	4⅛
189,700£	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	103 —106	104 —107	...	...
237,200£	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 —106	104 —107	...	...
88,321	West India and Panama Telegraph, Limited	10	1⅝ — 1⅞	1⅝ — 1⅞	1 13/16	1¾
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	10 — 10½	10 — 10½	10½	10⅜
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	8½ — 9½	8½ — 9½	9½	...
80,000£	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	99 — 103	99 —103	...	...
$1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	118 —122	118 —122	...	...
173,100£	Do. do. 6 p. c. Sterling Bonds	100	97 —100	97 —100	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	6¼ — 6⅜	6¼ — 6⅜	6⅜	...

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Blackpool Electric Tramway Company, Limited, £10 (£6½ paid) 7½—7¾.—Electric and General Investment, shares of £5 (£1 paid), 2—2½.—Founders' shares, 150—200.—Elmore Foreign and Colonial Copper, Founders' shares, 6¾—7¼.—European Sims-Edison Torpedo Company, shares £20 (fully paid), 20—20½.—Founders' shares, 10—20.—Halifax and Bermuda Cable, 4½ per cent. bonds 80—90.—House to House Company (£5 paid) 2¾—3¼.—7 per cent. Preference Shares of £5 (fully paid) 5½—5¾.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5¾—6, 1st Preference Cumulative 6 per cent., £5 (fullypaid), 5¾—6.—Liverpool Electric Supply Shares of £5 (fully paid), 5—5⅛.—Do. shares of £5 (£3 paid), 2⅝—2¾.—London Electric Supply Corporation, Ordinary (£5 paid), 1—1¼.—Do. 6 per cent. Preference, 1¼—1⅜.—Manchester, Edison and Swan Company, £9 (£1 paid), ⅛—¼.—Metropolitan Electric Supply Company, Founders' Shares, 300—400.—Queen Anne's Mansions Lighting and Heating, Deferred shares of £10 (fully paid), 10—¼.—Do. 4½ per cent. preference shares of £10 (fully paid), 10—¼.—Do. Debentures, 103—¼.—Woodhouse & Rawson Ordinary of £5 (£2 10s. paid), ⅛—¼.—£5 Preference (fully paid), 2½—2⅝.—Ward's Electric Car (£10 paid), 1⅜—1⅝.

BANK RATE OF DISCOUNT.—2½ per cent. (April 7th, 1892).

THE COMPASS: HISTORICAL, THEORETICAL, PRACTICAL.*

By Capt. D. WILSON-BARKER, Lieut. R.N.R. (of the Silvertown Telegraph Company's Staff).

Historical.

The earliest mention of the loadstone having the property of communicating its mysterious nature to iron is in a Chinese dictionary in the year 121 A.D. We find the earliest reference to the compass in the 64th year of the reign of Ho-ang-ti (2634 B.C.). The Emperor Ho-ang-ti attacked one Tchi-yeou in the plains of Tchoulou, and, finding his army embarrassed by a thick fog raised by the enemy, constructed a chariot for indicating the south, so as to distinguish the four cardinal points, and was thus enabled to pursue and capture Tchi-yeou. The name of this chariot or compass-carrier was Tchi-nan (chariot of the south), and it is remarkable as illustrating the conservatism of this extraordinary people that it is little different from their name for it in present use. We also see from this that the four cardinal points were thoroughly recognised.

The first authentic mention of the use of the compass at sea is in the great Chinese Encyclopædia Poi-weu-yun-fou between the years 265-419 A.D.

The earliest European mention of the cardinal points is in Homer's Odyssey, Book V., where describing the situation of the wrecked *Ulysses*, the poet says:—

> "The rolling flood,
> Now here, now there, impell'd the floating wood
> As when a heap of gather'd thorns is cast,
> Now to, now fro, before the autumnal blast;
> Together clung, it rolls around the field;
> So roll'd the float, and so its texture held:
> And now the south, and now the north, bear sway,
> And now the east the foamy floods obey,
> And now the west wind whirls it o'er the sea."

They used E. and W. as we use N. and S; thus they spoke of an E.N. wind instead of a N.E. wind, and so on. But though the Greeks and Romans were aware of the magnetic properties of certain substances, no mention is made of the compass until the end of the 11th century, when from the remarks made by Ara Frode, a Norwegian historian, there is strong evidence that the compass needle was known; and within the next hundred years its use had spread all over Europe.

Various assertions have been made that it was invented in Europe, Flavio of Amalfi generally receiving the credit—indeed, the compass appears on the arms of the province in which he was born; but it seems that this idea probably sprung from his being the first to attach the card to the needle, an invention in itself quite sufficient to make his name famous. It was, however, some time before this improvement came into general use.

We have the following interesting account of the compass, as used on board ship, from a MS. by Bailak in 1242: "We have to notice amongst the properties of the magnet, that the captains who navigate the Syrian seas when the night is so dark as to conceal from view the stars which might direct their course according to the position of the four cardinal points, take a basin full of water, which they shelter from wind by placing it in the interior of the vessel; they then drive a needle into a wooden peg or cornstalk, so as to form the shape of a cross, and throw it into the basin of water prepared for the purpose, on the surface of which it floats. They afterwards take a loadstone of sufficient size to fill the palm of the hand, or even smaller, bring it to the surface of the water, give to their hands a rotatory motion towards the right, so that the needle turns on the water's surface; they then suddenly and quickly withdraw their hands, when the two points of the needle face N. and S."

The early compass bowls were made of wood or china, and were marked with lines at right angles inside for the four cardinal points; the magnetised needle was then floated in water in the bowl, either by being supported by a piece of wood or cornstalk, as before described, or else placed on a pivot which was surrounded by water; or the needle was sometimes made in the shape of a fish which floated loosely in the bowl. The first needles made were very small and short, those suspended by the Chinese being particularly sensitive, but they were (in Europe) gradually made longer, so that they might be more easily seen, until in the 16th and 17th centuries we find them 6 inches to 9 inches long. It is curious to note in connection with this the recent return to short needles.

We have no mention of the deflection of the compass needle from the N. and S. direction commonly called the variation, until the middle of the 13th century; and its true meaning was not understood until Columbus took his celebrated voyage across the Atlantic in 1492, but in the 17th century we find the azimuth compass in regular use. At what time the word "compass" was first employed, is unknown, but we find that in the 14th century the compass was known as an "adamant" or "sail-stone."

In 1544, Hartmann discovered the inclination or dip of the needle; but to Robert Norman, "a skilled sailor and ingenious artificer," belongs the credit of, in 1576, establishing it as a fact. In Dr. Gilbert's book "de Magnete," published in 1600, we find a very full account of magnetism, as it was known at that time, and this treatise is really the foundation of the modern science of terrestrial magnetism.

Barlow, writing in 1616, describes "the compasse needle being the most admirable and useful instrument of the whole world, is both amongst ours and other nations for the most part so bungerly and absurdly contrived, as nothing more," and recommends a circular form of needle. From this we see that improvements were being considered, and in 1750, Dr. Govan Knight describes a needle made of two pieces of steel bent in the middle, and united in the shape of a rhombus. Dr. Knight recommended thin straight steel bars, suspended edgeways, a plan which was soon adopted and is even now in use.

The advent of iron vessels marks an epoch in the compass, and soon called for the energies of scientific men, foremost among whom stands the late Astronomer-Royal, Sir G. B. Airy, and A. Smith, the former of whom investigated and invented mechanical correctors, and formulated the laws which govern the magnetic state of vessels, and in Sir William Thomson's (now Lord Kelvin) compass we find almost perfectly realised the practical application of these mechanical correctors.

Theoretical.

It is found that the greater part of magnetism is contained on the surface of a magnet—a most valuable circumstance, and one which has been only recently taken full advantage of in the construction of compasses. It is an extraordinary fact that the magnetism of the earth is separated, and various hypotheses have been put forward to account for it. Of these I need only mention two. Biot supposed the magnetic nature of the earth to be such, that it might be represented by a magnet at the earth's centre, having a length small in comparison to the earth's radius, and making an angle of about 20° with the axis of rotation. Barlow, on the other hand, accounts for the phenomenon by supposing that currents of electricity are continually passing round the earth from east to west. The resulting action of the magnetic needle, supposing either of these hypotheses to be true, will be practically the same.

If a magnetised needle be suspended so as to freely move in any direction, it will be found that in certain places it will assume a perpendicular position, and in other places a horizontal position, and between these places will have various angles of inclination. The places where the needles dip perpendicularly are called the magnetic poles, and the place where the needle remains horizontal, the magnetic equator. The position of the N. magnetic pole was reached by Commander (after Sir James) Ross in 1831, its position being lat. 70° 5′ N., long. 96° 43′ W. The same navigator nearly reaching the S. magnetic pole between 1839—43, its position being deduced from observations as lat. 73° 30′ S., long. 147° 30′ E.

We are indebted to Humboldt for first calling attention to the international importance of establishing stations for regular observations of the earth's magnetism, of which the most celebrated was that at Göttingen, under the direction of Gauss and Weber, to whom we owe the whole system of observation and most of the delicate instruments used. From the observations taken in various places, maps have been constructed showing the positions of equal dip connected by lines called isoclinic lines, places of equal variation by lines called isogonic lines, and places of equal force or magnetic intensity by lines called isodynamic lines. These forces are continually changing, there being a secular movement, small diurnal and annual fluctuations depending in some manner upon the sun's influence, and still smaller fluctuations depending on the moon, besides the occasional disturbances known as magnetic storms. So rapid is the change in the variation in some places that serious errors may arise in steering a course unless the change is carefully attended to. There are also places which are apparently local foci of magnetic disturbance; a fact which has been well known to sailors for a long time, but has only recently been placed on a sure footing.

We will now consider the effect the magnetism of the earth has upon iron and steel, the materials of which vessels are constructed. This effect appears to have been first noticed by a Frenchman named Dennis as long ago as 1666. In the first place it is necessary to see the difference between "soft" and "hard iron." In the soft iron the magnetism changes with change in position, the change taking place with the greatest rapidity; in the latter it does not, becoming practically permanent; but the induced magnetism can be fixed in soft iron by the simple method of hammering it. For instance, take a piece of iron rod, hold it in a line with the magnetic meridian, and the end which is pointing northwards becomes—through the induced magnetism of the earth—a magnet, having magnetism of an opposite nature to that of the north pole of the earth, that is to say, it will repel the north-seeking end of the compass needle; if the rod be held in the line of total force the effect is increased. Now reverse the bar, and the same effect is produced with the other end. If, however, the bar be hammered when held in either of these positions, the magnetism becomes permanent, and the bar is to all intents and purposes a magnet having a north and south pole. If now the bar be again reversed, and again hammered, the amount of magnetism will be reduced, and its attractive power will not be so great. From this you will quite understand that when a vessel is built she becomes a huge magnet from the induced magnetism being fixed by the hammering going on all over her; the magnetism will be distributed according to the direction of the fore-and-aft line with the magnetic meridian. From the experiment with the iron rods, it will be readily seen that it will be advantageous—after the ship is launched and while being finished—to place her fore-and-aft line in a direction opposite to that in which it was while building, as by this means the loose magnetism—if I may so term it—is knocked out.* Attempts have been made to demagnetise vessels, but with no success, as could well be imagned.

After a vessel goes to sea, it is found that there is still some slight diminution in the permanent magnetism, and this diminution would continue to go on very slowly were there not other causes at work to effect slight changes in the vessel's magnetism, and which require constant vigilance on the part of those on board to check. For

* Abstract of paper read before the Shipmasters' Society, March 18th, 1892.

* The general effect of the ship's magnetism is to reduce the directive power of the compass needles.

instance, if a vessel be kept long on one course, the battering of the waves will affect temporarily her magnetic character, and when the course is altered care should be taken to allow for this, although the effect produced may be quite transient. The permanent magnetism of the ship produces the greater part of the semi-circular deviation, which is expressed by the co-efficients, B and C;* B representing the fore-and-aft magnetic forces of the ship, with its zero effect when the ship's head is N. or S.; and C, the transverse force, having its zero effect when the ship's head is E. or W. The horizontal masses of soft iron in the ship as girders, &c., produce the quadrantal deviation expressed by the co-efficients D and E, and have their combined greatest effect on the inter-cardinal points. The co-efficient, A, is always small in amount, and is generally due to some defect in placing of the lubber's line, or may be due to compass being placed too near some mass of iron. If it is large in amount, rigorous investigation should be made of the cause, and steps taken to remedy it.† Changes in the nature and distribution of the cargo below decks should be taken into consideration, though, as a rule, its effect on the compass is likely to be very small.

When vessels are being fitted with the electric light, care should be taken about the position of the dynamos and the leading of the wire. As a general rule, no dynamo should be nearer to the compass than 60 feet, nor should any main wire pass closer than 20 feet: and it is advisable that the hull should not be used for the return current.

For all practical purposes, it is quite sufficient to determine the approximate co-efficients, A, B, C, D and E. From these, the probable changes of the deviation may be predicted very easily, and are often useful as giving an idea beforehand of the nature of the alteration on change of geographical position.

A vibrating needle will be found a useful adjunct, as the magnetic ratio between the position of the compass in the ship and a place on shore, free from all magnetic influence, can easily be determined, and the directive power of the compass needles determined.

The Sir William Thomson deflector is designed to carry out practically an idea proposed nearly 50 years ago, by Sir E. Sabine, for the determination of compass errors, whether at sea or in harbour, without the aid of extraneous objects, and can be used for determining all the co-efficients except A. The instrument is very ingenious, and would be a valuable addition to any ship's outfit; but I am afraid its use in practice would have to be entirely confined to times when the ship is in harbour, as few would care or should interfere with their compasses while the vessel was in motion, unless the sea is perfectly smooth.

Practical.

When a vessel is designed, the position of the compass‡ appears, in a great many cases, to be about the last thing thought of, whereas it ought really to be one of the first considerations. I do not think I am overstating the case when I say that the constructor should have in his mind the position of the compass in the earliest stage of construction, which position should be checked when the vessel is completed by observations with the vibrating needle.

I am convinced that as many of the bad courses steered with disastrous results to ship and crew are due to the inaccessible position of the compass, preventing continual checking of the steering of the ship, as are due to undetermined errors in the compasses themselves. One has only to walk through the docks to see the positions in which compasses are placed to verify this. I can only say that the navigation of such vessels must be very rough indeed. Even in the case where a master may find his compass badly placed, he may often remedy this himself by moving it, a few inches even making a great difference, and increasing the directability of the needles considerably. For, while the attractions and repulsions of magnetic masses are inversely as the square of their distance, the attraction between a magnetic mass and an induced magnetic mass, which is the product of these magnetisms, will be inversely as the fourth power of the distance, so§ that it is easy to see that moving the compass only a very short distance may be of considerable advantage.

We have now to consider the compass itself, and here again we find the greatest diversity. One of the most frequent causes of bad instruments is the practice of allowing cost to enter into the consideration of their purchase. A compass cannot be depended upon unless it is of the best manufacture. The pivot should be made of a natural alloy of iridium and osmium, and the cup in which it works of sapphire or ruby, which itself should be examined before fitting, as the nature of the material is no absolute guarantee of its freedom from cracks, &c. From the ease with which the card works on the pivot will result a compass card which will not "hang." This may be tested by vibrating the card and noting if it always returns with the same degree opposite the lubber's line, &c. The pivots and caps should be examined carefully with a magnifying glass, at least every three months, for possible flaws; and should anything of this sort take place, a spare card should be shipped, and no attempt made to remedy the defects, except by a skilled workman. The change in the deviation should, of course, be attended to in such a case.

Sometimes, when the ship is rolling heavily, the compass will be found to be very uneasy. This may be due to the change in magnetism owing to heeling error, but is more probably caused by the isochronism that exists between the periods of the vibration of the needle and "swing-swang" of the ship, and it is then advisable to change the card for one having a different period. As a rule cards having a long period of "swing-swang" behave best in heavy rolling.

The demand for cheap articles has flooded the market with a lot of rubbish of the most dangerous description, and I think shipmasters should take steps in the matter to ensure at least that their standard compass is a thoroughly good one, and that it fulfils the conditions pointed out.

There is another matter masters should also satisfy themselves on, and that is the ability of the men employed to adjust their compasses. As a rule this is done well, and from their experience those employed are able to adjust the compass in a satisfactory and trustworthy manner, and very quickly; whereas a master, with his many other duties, just at the last moment is not able to attend properly to this important question; but he should take the earliest opportunity of verifying the results given him. The general custom of swinging a vessel only one way is rather faulty, and when there is time it would be of great advantage to swing the ship both ways, and take the mean of the results.

Those who have thoroughly mastered the theoretical considerations connected with the compass will be able, where it is necessary, to shift their adjusting magnets in a correct manner, when making considerable changes in geographical position; but this meddling with magnets is to be deprecated, unless the master has at his fingers' end the effects they have on the compass needles. The whole secret of the adjusting of the compass lies in the correction of a force by the application of a similar force in a diametrically opposite direction.

Care should be taken in cleaning the glass cover to the compass bowl, as it is quite possible to set up a temporary attraction between the glass and the card, which might lead to mistakes in the setting of a course.

The lighting of the compass at night time is often a source of considerable trouble—lights burn low or go out, often at critical times, oil overflows or candles melt, and many other inconveniences arise. Binnacles have been fitted, so that the card is illumined from below, and it certainly would seem to be by far the best plan. The amount of light required is small, but it should be steady and certain in its action, and the amount of illumination might easily be under the control of the "officer of the watch" without removing the lamps.

The marking of compass cards from 0° to 360°, instead of as now in the different quadrants to 90°, would, I think, be a step in the right direction, and would simplify the application of compass errors.

* The remainder of the semi-circular deviation is caused by soft vertical or inclined iron, and is subject to alteration through change in geographical position.

† In a badly designed vessel, the effect of superstructures near the compass may be so great as to entirely mask the effect of the permanent magnetism.

‡ Throughout this paper the standard compass is implied.

§ Airy, "Treatise on Magnetism."

LONDON COUNTY COUNCIL.

The following report of the Highways Committee was received last week:—

Notices under Electric Lighting Acts and Orders.

The council on March 1st authorised us, up to and including the last day of its term of office, to deal with any matters within the scope of our reference which might require immediate action on behalf of the council. Acting under this authority we have considered the undermentioned notices, and conditionally sanctioned the works referred to therein.

Notices.	*Conditions attached to sanction of Works.*
(*a*) Notice, dated March 7th, 1892, from the Crystal Palace District Electric Supply Company, of intention to lay mains in Sydenham Hill Road and Avenue, Wells Road, Springfield Road, Jews Walk, High Street, Kirkdale, West Hill, Crystal Palace Park Road, Lawrie Park Road and Gardens, Border Road and Crescent, Westwood Road, the Private Road, Anerley Road, and Westow Hill. (2 plans and schedule.)	(*a*) That the company do give two days' notice to the council's chief engineer before commencing the work; that proper drawings and details of the proposed street boxes and their covers be submitted to the council for approval before any of the works be commenced; and that double covers be used for the high tension boxes.
(*b*) Notice, dated March 4th, 1892, from the Kensington and Knightsbridge Electric Lighting Company, of proposed extension of mains in part of Brompton Road and part of Knightsbridge Road.	(No conditions necessary.)
(*c*) Notice, dated March 5th, 1892, from the Chelsea Electricity Supply Company, of intention to lay mains in Sydney Place, South Kensington, on the north side of Onslow Square, across Pelham Place, and partly around South Kensington Railway Station.	(*c*) That the company do give two days' notice to the council's chief engineer before commencing the works; and that the works shall be of the same character as those of this company previously approved by the council.

We recommend that the council do ratify the action taken with reference to the above notices.

We have to report the receipt of the undermentioned notices, given in accordance with the resolution of the council to accept four days' (instead of one month's) notice in respect of the laying of service lines from mains already laid:—

From the Electricity Supply Corporation: February 26th, 1892, to

the County Hall, Spring Gardens; March 2nd, 1892, to "The Prince" public house, Buckingham Street; March 3rd, 1892, to 4, Prince's Buildings, Coventry Street.

From the House to House Electric Light Supply Company: February 26th, 1892, to 21, Barkston Gardens: March 1st, 1892, to 22, Courtfield Gardens; March 2nd, 1892, to 16, Gledhow Gardens; March 4th, 1892, to 65, Harrington Gardens.

From the London Electric Supply Corporation: March 1st, 1892, to 54, Deptford Broadway; Victoria Institute, Adelphi Terrace.

From the St. James and Pall Mall Electric Lighting Company: February 29th, 1892, to 48, Regent Street; 1, 2, 7 and 8, Cork Street; 15, Clifford Street; March 4th, 1892, to 4 and 70, Regent Street; 37, Sackville Street.

Subways.

We have also, acting under the same authority, acceded to an application from the General Post Office for consent to the placing of a four-wire telegraph cable, with 1½-inch connections, in the subway of Shaftesbury Avenue between Nos. 16 and 22, a distance of 285 yards. This consent is subject to the provisions of the agreement between the Council and the Postmaster-General with reference to the use by the department of the Council's subways.

The following were submitted on Tuesday last:—

Electric Lighting—Applications for Provisional Orders.

We reported on February 2nd and March 1st that we had suggested to the Board of Trade certain amendments in the model order (form No. IV.), which the board proposed to adopt for use in cases where the local authorities apply for powers under the Electric Lighting Acts. Four such applications have been made this year; and the Board of Trade has forwarded, for the council's observations, two of the proposed orders, namely, those applied for by the Vestry of Hampstead and the Whitechapel District Board, in the form in which the board proposes to issue them, nearly all the amendments suggested on behalf of the council in the model form of order having been adopted. We have carefully examined these orders, which appear to us to be satisfactory; and we recommend that the Board of Trade be informed that the council approves of the form in which the board proposes to issue the orders applied for by the vestry of Hampstead and the Whitechapel District Board.

Subway—Charing Cross Road.

The Metropolitan Electric Supply Company has asked permission to place a telegraph line in the Charing Cross Road subway, between Cranbourne Street and St. Martin's Church, as a part of a circuit between the company's Whitehall station and its offices in South Street, Manchester Square. We see no objection to this line being placed in the subway, provided that rent is paid for the accommodation according to the scale laid down by the council. We recommend that the Metropolitan Electric Supply Company be allowed to place a telegraph line in the Charing Cross subway between Cranbourne Street and St. Martin's Church, upon condition that the company do pay to the Council a rent of £1 a year in respect of the accommodation.

Notices under Electric Lighting Acts and Orders.

We have considered a notice dated March 7th, 1892, from the St. James and Pall Mall Electric Lighting Company of intention to lay mains in Oxford Street (from Oxford Circus to Wardour Street, Argyll Street and Place, Little Argyll Street, Great Marlborough Street, Poland Street, Silver Street, Golden Square, Upper and Lower John and James Streets, and Warwick Street. It is intended that the mains shall be either with bare copper in a concrete culvert, or with armoured cables, or with vulcanised rubber cables drawn into bitumen ways or iron pipes, as may be found most suitable in each case. There appears to be no objection to what is proposed; and we recommend that the sanction of the council be given to the works referred to in the notice dated March 7th, 1892, of the St. James and Pall Mall Electric Lighting Company, upon condition that detailed drawings of the proposed works, together with full information as to the method to be used in each street, be submitted to and approved by the council's chief engineer before the works are commenced; and that, when such approval shall have been given, the company do give him two days' notice before commencing the works.

The London Electric Supply Corporation has given three notices, dated 8th, 18th and March 21st, 1892, respectively, of intention to lay distributing mains (*a*) in New Cross Road and the Broadway, Deptford; (*b*) in North Row, North Audley Street, Green Street, and Park Street; and (*c*) in Florence Road, Deptford. These mains will consist of concentric lead-covered cables drawn into iron pipes, and similar works of this company have been previously approved by the council. We recommend that the sanction of the council be given to the works referred to in the notice dated 8th, 18th, and 21st March, 1892, respectively, of the London Electric Supply Corporation, upon condition that the company do give two days' notice to the council's chief engineer before commencing the works; that the mains be laid under the footways, and be kept 9 inches below the under side of the paving wherever it is found practicable to do so; that where the mains cross the carriage-ways they be kept at the same depth below the concrete or the road material, as the case may be; that the positions of the street boxes, and the mode of construction of them, shall be submitted to and approved by the council's chief engineer; that all pipes or openings from or into the boxes shall be of such shape as to remove all risk of injury to the covering of the cables; that all cables crossing the boxes shall be supported from below in the boxes; that all service lines or small cables shall be protected, where leaving the boxes, by an extra lead covering or by wooden stoppers, and shall also have a copper wire of sufficient size carried from the service to the main cable, in good connection with the lead or iron outer casing; and that the ends of all mains terminating elsewhere than in a box shall be securely protected by iron caps, in addition to any other covering.

A notice, dated March 15th, 1892, has been given by Mr. H. Robinson, on behalf of the Vestry of St. Pancras, under the St. Pancras (Middlesex) electric lighting order, 1883, of intention to lay mains in a part of Drummond Street (1 plan, marked "K.") These mains will be laid in the existing cast-iron subway, and the details will be as previously approved by the council. We recommend that the council do signify its approval of the works referred to in the notice of the Vestry of St. Pancras, dated March 15th, 1892, under the provisions of the St. Pancras (Middlesex) Electric Lighting Order, 1883.

We have considered two notices, dated March 14th and 19th, 1892, respectively of the Kensington and Knightsbridge Electric Lighting Company, of proposed extension of mains in (*a*) Eldon Road, Stanford Road, Victoria Road, and Cottesmore Gardens, and (*b*) Brompton Square. The proposed works are of the usual character, and we recommend that the sanction of the council be given to the works referred to in the two notices dated March 14th and 19th, 1892, respectively, of the Kensington and Knightsbridge Electric Lighting Company.

We have also to report the receipt of the undermentioned notices given in accordance with the resolution of the Council to accept four days' (instead of one month's) notice in respect of the laying of service lines from mains already laid:—

From the London Electric Supply Corporation: March 8th, 1892, to the Ophthalmic Hospital, St. George's Circus; March 14th, 1892, to 27A, Old Bond Street; March 15th, 1892, to 91, Blackfriars Road; March 21st, 1892, to 67, Borough High Street; 48 and 50, Southwark Street.

From the St. James and Pall Mall Electric Lighting Company: March 9th, 1892, to 97, Jermyn Street; March 15th, 1892, to 134, Regent Street; 23, Pall Mall; 9, Cork Street; March 22nd, 1892, to 1B, Pall Mall Place; March 23rd, 1892, to 243—253, Regent Street.

From the House to House Electric Light Supply Company: March 17th, 1892, to 30, Earl's Court Square.

From the Electricity Supply Corporation: March 21st, 1892, to "Opera Tavern," James Street; "Ship Tavern," Whitehall; the "Bodega," Bedford Street; "Comedy Restaurant," Panton Street; Trafalgar Theatre, St. Martin's Lane; Messrs. Tooth's, Haymarket.

Ward Electrical Car Company's Bill.

The Parliamentary Committee state that this Bill is included in a group referred to a committee now sitting. The petition of the council has been met by the promoters acceding to the condition that the use of the cars should be subject to the license of the council. As this is satisfactory, we have authorised the agent to withdraw the petition, and we recommend that the course taken in withdrawing the petition be approved.

LEGAL.

The Anglo-American Brush Electric Light Corporation, Limited, v. King, Brown and Company.—Before the Lord Chancellor, Lord Watson, Lord Herschell, Lord Macnaghten, and Lord Field, in the House of Lords on Tuesday, April 5th. It will be remembered that this, the final appeal in this important case, was heard at the end of last year, the respondents' counsel, however, not being called upon. Their Lordships now delivered judgment, affirming the decision of the Scotch Courts, and pronouncing against the validity of the Brush patent.

The LORD CHANCELLOR said: This is an appeal against an interlocutor of the First Division of the Court of Session, affirming the interlocutor of the Lord Ordinary, setting aside the patent, of which the appellants are the assignees, on the ground that the portion of the invention patented, with which, under the circumstances, it is alone material to deal, had been previously published. The patent so set aside is known as Brush's Patent, and bears date November 16th, 1878, and the question in debate is whether a patent taken out by Mr. Samuel Alfred Varley in 1876 does or does not so anticipate the patent of 1878, of which the appellants are the assignees, as to make the latter patent bad. The patent has relation to the particular form of dynamo-electric machines, all of which have, and were known to have before the date of either patent, this principle in common, that they move magnets past coils of wire or coils past magnets, with sufficient velocity to produce the desired result. It was also familiar knowledge before the date of either patent that a current of electricity sent round a bar of soft iron would render the bar of iron magnetic. Undoubtedly the progress of electrical science has given rise to various forms of using that energy in which the two principles to which I have adverted have become important, and the practical application of them by means of different mechanical devices has for some time past exercised the ingenuity of practical electricians. One appears to have been the idea of making one wire go round the iron bar, make it and maintain it as a magnet, making the same wire go to perform whatever work it was intended to perform, and returning to the magnet, and thus the single current doing two things. The further step was made when what was called the shunt apparatus was invented. The current of electricity was divided into two. One stream, so to speak, was made to go round the iron bar, keeping it magnetic, while the other was led to do the work which it was required to do, and were rejoined after the work had been accomplished. Mr. Imray explains with great clearness what are the two principles called series and shunt winding. On the machine being revolved, he says, a wire wrapped round and round the magnet crosses over to another magnet, proceeds to do whatever work is required of it in what is called the

external or working circuit, and goes back again after doing the work. It is called "series" winding, because the coils of the electro-magnet are in series with the external circuit—that is to say, it is one continuous wire. The current goes straight from start to finish. The whole electricity produced by the machine goes to excite the magnet and to the external wire, and straight from the one to the other. The weak point of it, said Mr. Imray, is this—that as soon as you break the external circuit you will cease to have an electric machine, because there is no current. In electrical language, that is spoken of as having the external circuit opened. When the external circuit is broken or opened, the current ceases to flow, and you do not have the advantage of any magnetising action by the current going round the magnets of the machine. In the same way, the more resistance you put in your external circuit—that is to say, the more work you ask your machine to do—the less current will flow through the external circuit; and the more work you have the less you will be doing towards the magnetising of your machine. Resistance in wire mainly depends—first, upon the character of the wire and what metal it consists of; secondly, upon its transverse section; and, thirdly, upon its length. The longer the wire the greater the resistance; the smaller the section the greater the resistance; one kind of metal has more resistance than another. Roughly speaking, a short thick wire has much less resistance than a long thin one. Another form is what is called "shunt" winding, in which the difference is simply in the disposition of the wires. The current coming away is split into two. One portion of it goes to what has been called the external circuit, doing whatever is to be done, and having done that work returns to the machine, but without any actual contact with the magnets of the machine at all. The other portion goes straight to the magnet, is wrapped round it as before, and then returns to the brush, as it is called, without any contact with the external circuit at all. The strong point, says Mr. Imray, of this arrangement is that, whether the external circuit is open or closed, there is always magnetism in the wire capable of producing electricity, because the current is continually running through the shunt to the magnet. A defect in it is that some of the electricity is taken away from the external circuit, which otherwise would go through it. One further explanation of Mr. Imray's becomes necessary to follow the question with which your Lordships have to deal, and that has reference to what Mr. Imray says is variously known as "electromotive force," "tension," "pressure," and "potential." "Potential" seems to be the word generally used, and means the intensity of pressure by which the electricity is caused to pass along a conductor. The advantage of what is called a compound winding, which is neither more nor less than a combination of the two previously described, the first being known as "series" the second as "shunt," and the one in debate as "series-shunt," or compound winding, is in producing a constant pressure, or an equal volume, or an even current. It is difficult, except by finding analogies in other subjects of physical research than electricity, to convey the exact idea, but the advantage attained, at all events, is that when the work is changed in the outer circuit the amount of current that goes round the magnet is so changed that one compensates, or nearly compensates, for the other. Now, in the patent, patented in 1876, Mr. Varley says:—"Part of the electricity developed by the machine is 'diverted'" (and the word is significant) "to maintain the magnetism of the soft iron magnets, and the remaining portion is used to produce the electric light. There are several well-known ways of doing this" (this has been the subject of very violent comment), "but the method I prefer is to wrap the soft iron magnets with two insulated wires, one having a larger resistance than the other. The circuit of larger resistance is always closed, and the circuit of less resistance used for the electric light. When the electric light is being produced the greater portion of electricity passes through the circuit of less resistance which I term 'the electric light circuit,' maintaining the magnetism of the magnets and producing the light. When the electric light circuit is opened from any cause the electricity developed passes through the circuit of greater resistance only and maintains the magnetism of the magnets." It is impossible to deny, in the present state of electrical knowledge dealing with dynamos, but that the description given undoubtedly does disclose to anybody familiar with the principle of dynamo-electric machines and the medium by which the electric current is turned to account points to the very thing for which the patent was granted to Mr. Brush. But it is said that, for the purpose of judging of the novelty of the invention of 1876, one must, as nearly as one can, apply oneself to the knowledge existing at that date, and not apply what we have learned since, so as to interpret the language of the patent of 1876 by the light of later discoveries. I am not quite certain that I understand the application to this case of that principle of interpretation, which, however, I admit to be sound. The "series" was known, the "shunt" was known, and the language seems to me incapable of any other interpretation than that the patentee did mean to combine the two previously known systems. If he did, and disclosed the mode of doing it, the novelty of the later patent cannot be supported. I confess that I am unable to entertain a doubt that it was so disclosed. What he intended was, I think, conclusively shown by the original rough sketch produced. Distinguished electricians cavil at the mode of its disclosure, criticise the language (which is not, perhaps, the most felicitously chosen), and possibly suggest doubts as to what would have been the fate of Mr. Varley's patent if it had been attacked upon the ground of the insufficiency of the specification, but that is not the question to be determined here. The question is the disclosure of the invention, which consisted in the combination of two known forms of dynamo-electric machines. I doubt whether there is much to choose in clearness of exposition between the one patent and the other. I think it is certain that neither the one patentee nor the other had any very definite notion of the importance of the invention until a year or two later. The invention of incandescent light brought into prominence the importance of an even, uniform, and continuous flow of the electric energy. I am, therefore, of opinion that the interlocutor appealed from ought to be affirmed. I have confined myself, however, in arriving at this conclusion to the specifications themselves, aided by scientific witnesses, in interpreting the scientific nomenclature in which the specifications are couched, and the explanations of the witnesses as to the operations produced by the different forms adopted. I designedly avoid giving any opinion upon the question of the user of Varley's machine. Many questions, to my mind, arise as to what publication there was from the use of that machine as a machine disclosing the mode by which the electric light was produced. But inasmuch as I have come to the conclusion that I have indicated, it is not necessary further to discuss the extent to which the use of the electric light by means of Varley's machine for the purpose of illustrating some submarine invention was such an exhibition or publication of it as would make a subsequent patent void. I therefore move your Lordships that the interlocutor appealed from be affirmed, and this appeal dismissed with costs.

LORD WATSON: The appellants are assignees of Brush's patent of 1878 for improvements in apparatus for the generation and application of electricity for lighting, plating, and other purposes. The patent originally included two different dynamo-electric apparatus, now known respectively as the shunt and the series-shunt; but in 1882 the appellants, having become aware of the fact that their shunt-winding machine had already been fully described and claimed in Clark's patent of 1875, amended their specification by disclaiming that part of it which related to shunt-winding, and limiting their claim to the series-shunt. In this appeal they complain of a decision of the First Division of the Court of Session, affirming an interlocutor of the Lord Ordinary, by which he reduced and set aside their letters patent as amended by disclaimer on the grounds, *inter alia*, that the series-shunt apparatus therein described had been published in Varley's patent of 1876, and also that there had been prior public user. Dynamo-electric machines are useful for various kinds of work, but are now chiefly employed for producing light. I shall, in so far as it may be necessary to describe such machines, refer to them as if they were used for the latter purpose. At the date of Clark's patent the only known variety of self-exciting dynamos was the series-winding apparatus, in which the current of electricity generated in the revolving coils, after it has passed through the commutator, is conducted to and round the magnets and thence to the lamps, from which it returns to the machine, thus forming a single electric circuit, which performs the double function of magnetising the magnets and doing work. In the shunt apparatus the volume of electricity, after it has passed the commutator, is divided into two unequal currents by means of a shunt, or bifurcation of the conducting wire, which is in itself a common device. The smaller current is then made to circulate round the magnets, whilst the larger is led to the lamps; and they are again united just before they re-enter the machine. So that these currents form two separate circuits, that of greater resistance maintaining the supply of electric force in the magnets, and that of lesser resistance producing light. The series-shunt-winding apparatus is, as its name imports, a combination of the two systems already described. Its arrangements are practically the same with those of the shunt-winding machine, subject to this modification—that, after bifurcation, the larger current instead of being taken direct to the lamps, is, in the first instance, made to encircle the magnets. Accordingly the smaller current serves for excitation only, as in the shunt system, whereas the larger current serves both for excitation and for work, as in the series-winding system. Whether the series shunt system was first disclosed to the public by Varley in 1876 or by Brush in 1878, it seems to be certain that the real merit of the arrangement was neither understood nor appreciated until the subsequent discovery of the incandescent lamp. The efficiency of light produced by the incandescence of filaments of carbon depends upon the maintenance of a uniform and steady flow of electricity in the working circuit, which is now termed a constant potential. In the series and also in the shunt system the working current is liable to considerable variation; with this difference—that the same disturbing elements which in the one case cause a decrease in the other occasion an increase of electromotive force. The combination of these opposite tendencies brings into play the principle of compensation, and makes it possible, by careful adjustment, to attain a more constant potential with the series-shunt than with either of its component systems. The terms of Brush's specification indicate that the patentee had not in his view the attainment of that high degree of constancy in the electromotive force which is desirable for the purpose of incandescent lighting. He points out that other machines were "not well adapted for certain kinds of work, notably that of electro-plating," and then proceeds to describe his own in these terms:—"I attain my object by diverting from external work a portion of the current of the machine, and using it either alone or in connection with the rest of the current for working the field magnets. I prefer the latter plan of the two, especially for electro-plating machines." In other words he attains his object by using either the shunt or the series-shunt, but prefers the latter for electro-plating. For other purposes than electro-plating he does not suggest that the one system is in any respect greatly preferable to the other. As matter of fact it appears to be doubtful which of the two is most suitable for plating. Mr. Preece, one of the appellants' skilled witnesses, says:—"Pure shunt is preferred in England for electro-plating. In America the compound is preferred." In Varley's patent of 1875 no claim is made either for shunt or for series winding. The passage which has been held, by both Courts below, to anticipate the invention claimed by the appellants, is merely descriptive of the machines to which the arrangements claimed by Varley, may be usefully applied, and is in these terms:—"Part of the electricity developed by the machine is diverted to maintain the magnetism of the soft iron magnets, and the remaining portion is used to produce

the electric light. There are several well known ways of doing this, but the method I prefer is to wrap the soft iron magnets with two insulated wires, one having a larger resistance than the other. The circuit of larger resistance is always closed, and the circuit of less resistance is used for the electric light. When the electric light is being produced, the greater portion of electricity passes through the circuit of less resistance, which I term 'the electric light circuit,' maintaining the magnetism of the magnets, and producing light. When the electric light circuit is opened, from any cause, the electricity developed passes through the circuit of greater resistance only, and maintains the magnetism of the magnets." In estimating the real significance of Varley's specification, it is necessary to consider what amount of information with respect to dynamo-electric apparatus ought to be attributed to persons who had an opportunity of reading it in the year 1876. The language used by the patentee must be construed with reference to the information then open to the public, and not in the light of subsequent discoveries. To my apprehension, it does not admit of doubt that a reader acquainted only with series-winding might not attach the same meaning to the words used by Varley, as would naturally occur to one who was also familiar with the shunt, or with the shunt and series-shunt systems of winding. Since the hearing of this appeal I have carefully perused the whole evidence adduced by both parties, in so far as it has any bearing upon the issue of prior publication. Of the respondents' evidence it is sufficient to say that it is in entire accordance with the decision appealed from. The appellants' evidence consists of oral testimony by electricians of great eminence, and is directed mainly, if not wholly, to prove (1) that, on a fair construction of the specification of 1876, the words relied on by the Court of Session do not disclose either shunt or series-shunt winding, and (2) assuming them to do so, that the specification does not contain explanations or directions which would enable a workman of ordinary skill to construct either a shunt or a series-shunt machine. I need hardly say that it is for the Court, and not for the witnesses, to construe the terms of the specification; and that their evidence upon the first of these points is only material in so far as it may supply scientific facts, which ought to be taken into account in arriving at the true construction of the instrument. There is one circumstance which, in my opinion, seriously affects the value of the appellants' evidence upon both points. The testimony of their witnesses was given upon the footing that, in 1876, Clark's invention of the previous year was still unknown, and that those who read Varley's specification could have no knowledge of any system other than series winding. Upon that assumption, it occurs to me that a reader, whether man of science or skilled workman, would probably have been at a loss to discover what Varley meant, and might not have arrived at either shunt or series-shunt winding without some exercise of his inventive faculty. I am, however, unable to find any good reason for holding that Clark's shunt machine was unknown in the year 1876. It is true that in 1878 Mr. Brush had never heard of Clark's invention, and also that shunt winding was unknown to Sir William Thomson before 1879. But it appears to me that Clark's taking out a patent for his invention was, both in fact and law, a publication of it. I do not suppose that every electrician, however eminent, is by necessity personally cognisant of every invention patented within the bounds of his science; and the ignorance of two or more of them is unavailing to prove that the knowledge of others was equally defective. I cannot, therefore, avoid the conclusion that, in 1876, Chark's shunt-winding machine had been disclosed to the public, and must have been known to some, if not to all, electricians; and, consequently, that the controverted passage in Varley's specification ought to be construed on the footing that shunt winding was known at its date. I do not think it necessary to deal with the conflict of testimony as to the sufficiency of Varley's specification for the guidance of a skilled workman. The Lord Ordinary was of opinion that the appellants had failed to prove that part of their case. But I agree with his Lordship, and with the learned Judges of the First Division, in holding that the sufficiency or insufficiency of the specification for that purpose does not afford a crucial test of prior publication. Every patentee, as a condition of his exclusive privilege, is bound to describe his invention in such detail as to enable a workman of ordinary skill to practice it; and the penalty of non-compliance with that condition is forfeiture of his privilege. His patent right may be invalid by reason of non-compliance; but it certainly does not follow that his invention has not been published. His specification may, notwithstanding that defect, be sufficient to convey to men of science and employers of labour information which will enable them, without any exercise of inventive ingenuity, to understand his invention, and to give a workman the specific directions which he failed to communicate. In that case I cannot doubt that his invention is published as completely as if his description had been intelligible to a workman of ordinary skill. Assuming as, in my opinion, I am bound to do, that Clark's invention was known in 1876, I have no hesitation in holding that Varley's specification sufficiently describes both the shunt and the series-shunt machine. The first sentence in the passage already quoted contains an accurate representation of shunt-winding. The electricity developed by the machine is to be "diverted," which is the word used in the appellants' specification to denote bifurcation, into two parts, one for magnetising, and the "remaining portion" for producing light. These expressions plainly refer to a single current of electricity generated by the machine, which is to be split into two currents, one for excitation of the magnets and one for work, an arrangement which, according to the evidence, embraces all the essential features of a shunt machine. The sentences which follow appear to me to describe the series-shunt with equal accuracy. They commence with the statement that there are several ways of "doing this," that is, of obtaining a circuit of excitation and an electric lighting circuit from a single current, by dividing it into two portions. The method preferred is to make both circuits pass round the magnets, that of greater resistance being employed for excitation only, whilst that of lesser resistance excites the magnets, and also does the work of lighting. The series-shunt is evidently treated as a mere modification of the shunt system; and I think it might be reasonably regarded in that light by the patentee. The alteration in the mechanical arrangement of the apparatus is in itself trivial; and the possibility of thereby obtaining such a constant potential as would, at a future date, suffice for the purpose of incandescent lighting was not present to his mind. There might, as one of the witnesses suggest, still remain room for a patentable improvement upon the series shunt as described by Varley, consisting in an adjustment which would ensure a high degree of constant potential. No such possibility is indicated either by Varley or in Brush's patent of 1878. In the argument addressed to your Lordships, counsel for the appellants laid much stress upon these words occurring in Varley's specification:—"The insulated wire composing the helices is connected to the insulated wire surrounding the soft iron magnets of the machine, and is usually inserted in the circuit of greater resistance." They maintained that the necessary result of giving effect to that direction would be to deprive the apparatus contemplated by Varley of all the characteristics of series shunt winding. The point does not appear to have been pressed in the Courts below; at least, it is not noticed by any of the judges. In the absence of evidence to support the appellants' contention, I have come to the conclusion that the adjustment thus indicated might affect the constancy of the volume of electricity conveyed by the electric light circuit, but that the apparatus would still be a series-shunt winding machine. These reasons are sufficient to dispose of this appeal; and I desire to express no opinion upon the matter of prior public user. The argument of the appellants satisfied me that the question was one upon which I should prefer not to form any conclusion without hearing counsel for the respondents. I therefore concur in the judgment which has been moved by the Lord Chancellor.

Lord Herschell delivered judgment to the same effect, and the other noble and learned lords having concurred,

The judgment of the Court below was affirmed, and the appeal was dismissed with costs.

Savory and Moore v. London Electric Supply Corporation, Limited.—In the Supreme Court of Judicature, Court of Appeal II., before Lords Justices Lindley, Bowen and Kay yesterday week. This was an appeal by the defendant company from the judgment of Mr. Justice Kekewich, dated 18th December, 1891, whereby that learned judge ordered that the defendants, their contractors, servants, agents and workmen be perpetually restrained from so using the buildings mentioned in the statement of claim for converting electric currents at extra high pres sure in such a manner as to occasion a nuisance and danger to the plaintiffs, the well-known chemists of 143, New Bond Street. It appeared that the defendants had been using certain adjoining buildings as an electric light distributing station, and the plaintiffs complained that two fires had broken out, and that there was great risk of their valuable chemicals being injured. The defendants' case was that having satisfied the Board of Trade requirements and taken additional precautions the plaintiffs were amply protected from all risk. The learned judge held (hence the appeal) that the fires that had occurred rendered the plaintiffs' alarm natural and justifiable, and, in view of the uncertainty about the properties of electricity, granted the injunction.

The case for the appellents was being opened by Mr. Moulton, Q.C., when the Court suggested that the parties should come to a compromise.

Mr. Moulton said he was perfectly willing to give an undertaking that no transformers should be put on the ground floor until it had been made as fire-proof as the basement was now.

Mr. Rigby, Q.C., on behalf of the respondents, was not quite satisfied with that.

In the result, after a little discussion, both parties expressed themselves satisfied with the following order, which was drafted by Lord Justice Kay:—The defendants undertaking not to use any room except the basement for transforming until the defendants had satisfied some person to be agreed on between the parties that it is safe to do so, and not to store inflammable materials in any room in which transformers are used, the injunction be dissolved, the defendants paying the costs of the action and of the appeal.

Electrical Engineering Corporation, Limited.—The case of Dovey *v.* Pixley, which was decided by Mr. Justice A. L. Smith without a jury in the Queen's Bench Division on Saturday, was an action brought against the liquidator of the Electrical Engineering Corporation, Limited, to recover between £200 and £300 for damage done to the premises formerly occupied by the Corporation at the Albert Embankment, Lambeth. Mr. Pixley denied personal liability.

Mr. Crump, Q.C., and Mr. Hextall were for plaintiff; Mr. A. Cohen, Q.C., and Mr. Bremner for defendant.

In March, 1891, the debenture holders sued the corporation to ascertain what charge they had upon the corporation property, and Mr. Justice North appointed the defendant receiver and manager in the action of Brunton *v.* Electrical Engineering Company. In April the corporation passed a resolution for voluntary winding up under the supervision of the Court, and defendant was appointed voluntary liquidator. The Court subsequently ordered a sale of the company's property on the premises, and it was in connection with the sale that the damage done in removing machinery that the present action was brought.

It was submitted on behalf of the defendant that unless the plaintiff could prove that the defendant as manager did something he was

not directed by the Court to do, there was no cause of action against him.

Mr. JUSTICE A. L. SMITH in giving judgment said it was clear that plaintiff had suffered damage, but the question was whether he could make the defendant liable. If the corporation had been worth anything the plaintiff had still his remedy and could prove for his claim, but having got an insolvent tenant he could not go against the liquidator who had never been tenant at all. He could not sue on the ground of covenant, nor on the ground of breach of duty or of tort. The defendant's answer to the action was the order of the Court. The plaintiff ought to have gone into the liquidation proceedings and taken what he could get: he could not now put his hand into Mr. Pixley's pockets.

Judgment for defendant with costs.

St. James and Pall Mall Electric Lighting Company.—In the Chancery Division of the High Court of Justice, on Tuesday the 5th inst., before Mr. Justice Stirling,

Mr. GRAHAM HASTINGS, Q.C. (with whom was Mr. Ford), applied on behalf of the plaintiff, Mr. Love, for an interim injunction to restrain the defendants, the St. James and Pall Mall Electric Lighting Company, Limited, from building their large central station in Carnaby Street, in such a way as to obstruct the plaintiffs' ancient lights. Plaintiff was, counsel stated, owner of two houses opposite the site bought by the defendant company, on which the company are now erecting a new central station. From what the plaintiff had seen of the plans, he believed the company were going to build all along the site to a height 2 feet above the height of the old buildings which the company had pulled down, and that opposite his property the additional height would be 10½ feet. They were also going to build a chimney stalk 25 feet wide and 200 feet high, according to the evidence of the plaintiff and his architect. This would materially obstruct the light in the plaintiff's houses, and therefore he asked the court for an injunction until the trial of the action or further order.

Mr. MAIDLOW, who appeared for the defendants, said that this action was brought under a total misconception. The company never intended to build according to the plans which seemed to have frightened his friend's client. They had shown the plaintiff what plans they would like to follow if an arrangement could be made, and negotiations were on foot with that view; but they had expressly told the plaintiff that they did not intend, except by arrangement, to follow the plan put forward.

Mr. HASTINGS asked if his friend would undertake not to do it.

Mr. MAIDLOW said he was willing to undertake not to build higher than the old buildings until either negotiations had been arranged, or until they had decided whether the negotiations had to be broken off, and the company resolved upon what plans they would be entitled to proceed. Meantime he would give an undertaking over the 13th, the last motion day of the present sittings, not to go beyond the height of the old buildings. By that time he hoped the negotiations would be satisfactorily concluded.

Mr. HASTINGS assented, on the condition that the defendants furnished him with their affidavits by Saturday; and Mr. Maidlow accepting the condition,

The motion was allowed to stand over.

Woodhouse and Rawson United v. A. Wright and Co.—In the City of London Court last week, before Mr. Commissioner Kerr, Woodhouse and Rawson United, Limited, sought to recover a debt due from the defendants, Messrs. Alexander Wright and Co., 40, Millbank Street, Westminster. The claim was not in dispute, but the defendants raised a counter-claim for goods supplied to the plaintiff company. Mr. W. Hicks, for the plaintiffs, said the counter-claim should have been brought against the Woodhouse and Rawson Electric Supply Company of Great Britain, and not against the plaintiffs, who were a distinct company altogether. The "United" Company was not connected in any way with the Electric Supply Company, which was in liquidation. The defendant said there were a great many Woodhouse and Rawson companies, and he believed they were all one and the same. Mr. Commissioner Kerr said no doubt the plaintiff company was practically the same as the other one mentioned. Mr. Hicks repeated his assurance that the companies were quite distinct. Mr. Commissioner Kerr said he should find for the defendant beyond the money paid into Court, disallowing any costs.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1891.

3,650. "An improvement in electric motors for electric clocks and for other purposes." L. POPE. Dated February 28th. 8d. Comprises an adjustable magnet, a circuit closer or commutator of novel construction, a novel pendulum, and other details. 8 claims.

3,765. "Improvements in and connected with electric arc lamps." L. H. BUCHANAN. Dated March 3rd. 8d. The object is to produce an arc lamp that will burn a great length of time while still employing but one set of carbons, and which lamp when burning will throw no objectionable shadow. 10 claims.

4,259. "Improvements in electric motors." H. H. LAKE. (Communicated from abroad by the Giant Electric Motor Company, of America.) Dated March 10th. 6d. Relates to electric motors of the multipolar type, and is an improvement upon the invention described in letters patent No. 7,867, May 20th, 1890. 2 claims.

NEW PATENTS—1892.

4,949. "The generation of electricity for electric lighting and other purposes." A. F. WILLMAN. Dated March 14th.

4,961. "Improvements in slide resistances for electrical purposes." A. MUIRHEAD. Dated March 14th. (*Complete.*)

4,988. "Improvements in electric circuit closers." C. E. THOMSON. Dated March 14th.

4,992. "Improvements in insulated electric conductors and means to be employed in their production." H. EDMUNDS. Dated March 14th.

5,002. "Improvements in electrical conductors and means for laying the same." G. WILKINSON. Dated March 14th.

5,052. "Electrically driven whipper for eggs, creams, sauces, and the like." G. DAVIS. Dated March 15th.

5,086. "Improvements in electric block signalling apparatus." W. P. HALL. Dated March 15th. (*Complete.*)

5,096. "Printing telegraphs." E. J. SILKMAN. Dated March 15th. (*Complete.*)

5,130. "Improvements in magnetic ore separators." G. G. CROSBY and D. C. A. THATCHER. Dated March 16th.

5,141. "Multiple fuses and switch for use in electric circuits." C. S. SNELL and WOODHOUSE & RAWSON UNITED, LTD. Dated March 16th.

5,161. "An improved telephone cabinet." J. S. VOST and F. R. FISHER. Dated March 16th.

5,186. "Improvements in electric arc lamps." L. LENCZEWSKI. Dated March 16th.

5,245. "Improvements in the production of caustic soda and carbonate of soda by electrolysis, and in apparatus therefor." J. PEDDER. Dated March 17th.

5,266. "Improvements in the mechanical construction of dynamo armatures." G. PERCIVAL. Dated March 17th.

5,311. "Improvements relating to the construction of electrodes for electrolytic purposes." J. C. RICHARDSON. Dated March 17th.

5,365. "Improvements in joints for electric light fittings." MUNRO'S ELECTRICAL MANUFACTURING CO., LTD., and J. MACFARLANE Dated March 18th.

5,380. "An improvement in pendant electroliers for electric lighting." G. W. READY and J. PALFREEMAN. Dated March 18th.

5,383. "Improvements in the means of synchronising alternating current dynamos and of working them in parallel and taking them out of parallel." J. A. KINGDON. Dated March 18th.

5,404. "Improvements in magnetic compasses." J. H. STEWARD. Dated March 18th.

5,409. "Improvements in secondary batteries." G. E. B. PRITCHETT and T. W. PRITCHETT. Dated March 18th.

5432. "An improved automatic electric security lock." E. D. TAYLOR. Dated March 19th.

5,442. "Improvements in galvanic batteries." J. F. BENNETT and F. A. COLLEY. Dated March 19th.

5,498. "Electrical pilot." C. A. STEVENSON. Dated March 21st.

5,511. "Means for arranging automatic shunt-circuits for electrical purposes." W. S. HEDLEY. Dated March 21st.

5,515. "Improved regulating device for the carbons of electric arc lamps." J. JERGLE. Dated March 21st.

5,526. "Electrical apparatus for producing flashes." SIEMENS BROTHERS & CO., LIMITED, and F. G. BAILY. Dated March 21st.

5,528. "Improvements in coin-freed telephone apparatus." H. S. J. BOOTH. (Communicated by C. Hermann, France.) Dated March 21st.

5,546. "Improvements in or connected with the electrolytic deposition of copper or other metals." J. W. SWAN. Dated March 21st.

5,579. "Improvements in dynamo-electric machines and motors, in direct current distribution, in leading in wires for incandescent electric lamps, and in the insulation of electric transformers." J. SWINBURNE. Dated March 22nd.

5,618. "Improvements in alternate current transformers." T. BOYDEN. Dated March 22nd.

5,634. "Improvements in electrically controlled elevators and switch mechanism for use therewith." J. Y. JOHNSON. (Communicated by N. Hiss, United States.) Dated March 22nd. (*Complete.*)

5,645. "Improvements in or connected with electric batteries." L. PYKE and E. S. HARRIS. Dated March 22nd.

5,652. "Improvements in and relating to conduits for electric-railway conductors." H. H. LAKE. (Communicated by the Thomson-Houston International Electric Company, United States.) Dated March 22nd. (*Complete.*)

5,654. "Improvements in dynamo-electric machines." A. C. REIGNIER. Dated March 22nd. (*Complete.*)

5,655. "An improved electric safety lamp." J. P. REES. Dated March 22nd.

5,712. "Improvements in and connected with diaphragms of telephones." G. L. ANDERS and W. KOTTGEN. Dated March 23rd.

5,732. "Improvements in or connected with electric light fittings." J. A. LEA, J. F. LEA, and A. H. LEA. Dated March 23rd.

5,735. "Improvements in connections for electric lighting." H. HIRST. Dated March 23rd.

5,748. "Improvements in electric meters." G. SHANN. Dated March 23rd.

5,750. "Switch for electrical circuits." E H. JOHNSON. Dated March 23rd. [Date applied for under Patents Act, 1883, Sec. 103, 25th August, 1891, being date of application in United States.]

5,812. "Improvements in arc electric lamps." H. R. LOW. Dated March 24th.

5,814. "Improvements in microphones and in apparatus connected therewith." Sir C. S. FORBES. Dated March 24th.
5,828. "An improved method of rapid tanning with the aid of electricity." C. K. FALKENSTEIN and K. K. FALKENSTEIN. Dated March 25th.
5,850. "Improvements in or connected with telephone fittings." R. J. URQUHART. Dated March 25th.
5,870. "Magnetic course indicator." A. O. ARNESEN and E. WOLNER. Dated March 25th.
5,891. "Improvements in or connected with holders or supports for the ear tubes of telephones." W. F. MATHEWS. Dated March 25th.
5,899. "Improvements in apparatus for adjusting and regulating the carbons of electric arc lamps." E. F. M. LOEVENBRUCK. Dated March 25th.
5,931. "Improvements in the construction of multipolar dynamo-electric machines." W. L. SPENCE. Dated March 26th.
5,933. "New accumulator battery for telegraph offices for military telegraphs in the field, also for lighting trams, omnibuses, carriages." G. SACCO. Dated March 26th.
5,954. "Improvements relating to volt meters." F. BROWN. Dated March 26th.
5,959. "Improvements in accumulators." J. SPISO and H. NOWAK. Dated March 26th.

NORMAL AND HISSING ARCS.*

By J. R. CRAVATH.

THE electric arc has heretofore been investigated more from a purely electrical than from a broad physical standpoint. The relation of voltage, current, resistance, &c., in different arcs has received more attention than the action taking place in the arc itself. In other words, the arc has been dealt with through the agency of the voltmeter and ammeter, rather than "face to face." The electrical part of the work having, therefore, been pretty thoroughly done, this paper will treat only of the action of the arc itself.

The normal, silent carbon arc, fig. 1, consists of a stream of carbon vapour appearing to arise from the boiling crater

FIG. 1 FIG. 2

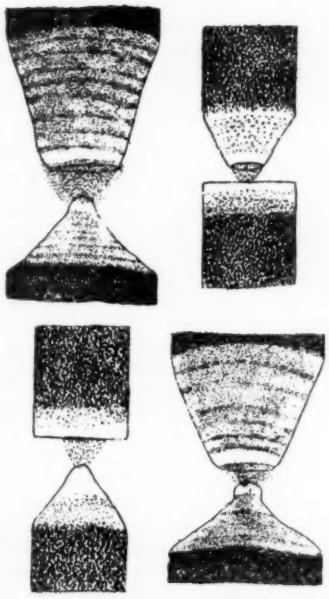


FIG. 3. FIG. 4.

Fig. 1, The normal silent arc; Fig. 2 and 3, Experiments upon carbon arcs; Fig. 4, The hissing arc.

on the positive carbon and touching the white hot point on the negative. This cone shaped stream of vapour burns where it comes in contact with the surrounding air. The whole surface of the crater is in a steady boil and gives off vapour equally from all parts. However, under certain conditions, the arc will hiss and become unsteady.

The conditions which produce hissing are: first, air currents, carbon impurities, &c.; second, shortness of arc. The following simple tests were devised by the writer during his investigations to locate definitely the part of the arc which is responsible for the hissing. Owing to the fact that hissing is always accompanied by unsteadiness, it was reasoned that it might be due to the changing of position of the vapour stream on either the positive or the negative carbon tips, and that the sound was caused by either the heating or cooling of the hot carbon, or by condensation of vapour on the negative.

An ordinary arc lamp was so fixed that one of the carbons could be moved in a horizontal direction without changing the length of the arc. It was then fitted with carbons, as shown in fig. 2, using an ordinary carbon (burned to the regular shape) for the positive, and one having a flat end for the negative. If now an arc be struck between these carbons any horizontal movement of one of them will simply change the spot on which the vapour strikes the negative without influencing the positive in any way. This movement was made when the arc was burning silently, and the arc continued to burn silently during the movements, showing that the hissing was not due to condensation on the negative.

The carbons were then reversed, using a pointed one for the negative and a flat ended one for the positive, as seen in fig. 3. In this case, of course, the positive crater will be obliged to change its position at every horizontal movement of the carbons. In this test every movement was accompanied with a hiss, showing that hissing is caused either by the sudden heating of the carbon to the boiling temperature of the crater, or by the sudden cooling of the boiling carbon formerly in the crater. The former theory seems most probable, for if the latter were true every arc lamp would hiss when the current is turned off, and this is not the case.

In the light of these experiments there is no difficulty in discovering the immediate cause of the hissing in short arcs. In looking at one (fig. 4) we see that, instead of a stream of vapour coming from the entire surface of the crater, there is a stream coming from only a part of the surface, and that the rest of the surface is at a temperature below boiling. The immediate cause of the hissing must be the fact that the boiling surface is constantly changing its position in the crater, and so constantly raising cool carbon to the boiling point.

The question still remains: why does not the evaporation cover the crater surface in the case of the short arc as in the case of the normal arc? With the idea that the vapour stream might have a certain geometrical relation to the crater, a system of measurements was begun on normal arcs, using the same current and quality of carbon. The measurements taken were on the diameter of crater, depth of crater, length of arc and diameter of the knob on the negative carbon. Fig. 5 is a diagrammatic section through an arc.

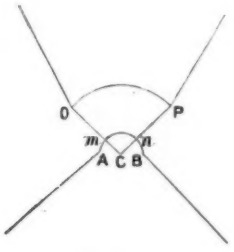


FIG. 5.

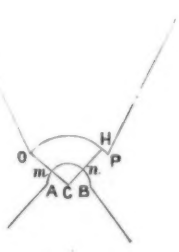


FIG 6.

The figures from which this was drawn were obtained by measurements of normal 10-ampère arcs, using a good quality of soft carbon. O, P, is, of course, the crater, and A, B, the negative tip or knob; O, *m*, *n*, P, is the vapour of the arc. The striking thing about this diagram is that C is the centre from which *m*, *n* and O, P, are described. This, however, shows what might be expected, namely, that the arc burns away the carbon, so as to keep all points at an equal distance from each other.

When it comes to the short hissing arc the measurements are more difficult. That is, the measurements taken on the normal arc will not amount to anything because the vapour stream, as was said before, does not come off from the entire crater but only from a part. Of course, exact measurements of the area of evaporation could not be made, but by examining the crater after the current was turned off the

* New York *Electrical World*.

area of the evaporation surface, just before it was turned off, could be noted by the peculiar appearance of the crater. By taking a number of measurements in this way, accurate enough results were obtained to draught a diagram shown in fig. 6. It will be seen that the angles, *m*, *c*, *n*, in figs. 5 and 6, are nearly equal, and I think it is safe to assume that if o, h, fig. 6 (the area of evaporation in the short arc), could be obtained with absolute accuracy, the angle at c would be equal in both cases. The diameter of the crater, o, p, is smaller in the short than in the normal arc, but there seems to be a point beyond which the crater ceases to decrease in diameter to correspond with the size of the vapour stream.

At this point the evaporating surface not being confined to a particular area, the arc begins to hiss. It is manifest that as the arc shortens, the crater will become more and more concave, and of course its edges will necessarily become sharper. The heat of the arc tends to wear away the edges of the crater, but as the arc is shortened and the concavity becomes greater, the edges do not wear away fast enough to keep down the crater surface. In the short arc the heat at the carbon tips is less than in the normal, and this fact will help to keep the crater edge from wearing. I use the word "wearing" to cover the three processes, namely, evaporation, combustion and disintegration, which consume the carbon outside of the crater. By evaporation in the crater I mean the active boiling which takes place there, though evaporation in general does not imply boiling. The decrease of heat which accompanies the short arc can be accounted for by the decrease of boiling crater surface.

The wearing of the crater edges will also depend on the quality of carbon used, and this is one of the reasons why some carbons will burn quietly with a much shorter arc than others.

The facts brought forth here do not pretend to be the results of any elaborate investigation, as they are no more than can be found out by any one with the use of an ordinary arc lamp. At any rate, it is safe to say that there is much yet to be written and discovered about the common everyday direct current arc.

CORRESPONDENCE.

Prof. Nollet's Historical Work.

Mr. Tanner's historical contributions which appear in your journal from time to time are always very interesting, so far as they relate to the electrical work of the ancients, that it is a pleasure to read them, and I think his letters of late must have opened the eyes of many would-be inventors, especially as these valuable contributions clearly show us that there is very little new under the sun, however clever and startling an invention may appear to be, especially when handled in modern style knowledge, which naturally tends to give them a bloom of freshness. It is evident from Mr. Tanner's researches, that one has only to dive into the ancient archives to find that many of the supposed modern inventions have been predicted and similar work recorded by others, and to make them workable perhaps only required the application of the modern theory of dynamics in lieu of chemically generated power to have made these fundamental ideas attain the desired success.

I may say my present object is not to criticise Mr. Tanner's interesting communication, but rather to add further information relative to the work of Prof. Nollet, who, like many others, was undoubtedly before his time; at the same time, it must not be lost sight of, that Nollet obtained many hints relative to his early experimental work from other associates, including Mr. E. C. Shepherd and Henry Tooth, engineers, late of Westminster, and also much assistance from his intelligent workman, Mr. Joseph Malderon, who, in conjunction with Prof. Holmes and M. Berlioz, a French engineer, were the actual persons who completed the now historical Alliance machine, which was built long after the decease of Prof. Nollet, on behalf of the Anglo-French Company, which machine, as the records show, was to a great extent a modification of the Clarke-Stöhrer and Millward's machine. I may say amongst my collection of historical plant, I happen to be the happy possessor of a small machine, supposed to be built by the late Henry Tooth, of Gateshead, the pedigree of which I am tracing up through the relatives of the late owner.

I note that Mr. Tanner gives the year 1851 as the advent of Nollet's invention; this should be altered to 1850 as it was on October 24th of that year that Mr. Shepherd filed Nollet's specification, No. 13,302, in the English Patent Office. Being a staunch believer in giving the credit where credit is due, I beg leave to couple the above names with the early work of Prof. Nollet, who it may be interesting to some of your readers to know that this inventor was a descendant of the celebrated "Abbé" Nollet of historical renown. If you can find space to record the above facts, please do and oblige.

Arthur Shippey.

The English Patent Law.

The recent case of Lane-Fox *v.* Kensington and Knightsbridge Electric Light Company has brought into prominence the anomalies of the patent laws of this country, or rather the want of patent laws.

It appears to me a monstrous state of things, that fees of over £150 are taken by the Government, and the inventor put to much trouble and many expenses for patenting alone (not taking into consideration the expenses of investigating, testing, and of perfecting his invention), and that after all he has absolutely no rights guaranteed to him, except those in common with others, of wasting his money in law if he wishes to uphold his patent. I cannot see any *quid pro quo* for the £150.

Mr. Lane-Fox, when his patent was nearly 14 years old, had to fight his claim to that patent, and only to find that his patent was not a good one in the eyes of the law, and he has to pay the enormous costs of that action as the recompense for being an inventor with the spirit to uphold his supposed rights.

Mr. Leng, M.P., has been taking action in the House of Commons, and has obtained a promise from the President of the Board of Trade to remedy and revise some of the patent laws.

The Patent Office is the nursery in which our industries are born, and which helps to spread the commercial prosperity of this country; it is only fair and right that the investigators and inventors should be protected, and should not have to pay fees for nothing, and be misled as they now are, from ignorance of the patent laws, in their anticipation of a real protection.

What is wanted is:—

1. A thorough examination, by Government examiners, as to invention, as to priority, and as to the drafting of the patent specification, and a certificate of that examination, as is the case in the United States of America, and in Germany.

2. One fee only, and that payable at the granting of the patent.

Practically, to make the fees and patent in this country the same as in the United States of America. Under the present system, anyone can take a patent and practically, word for word, copy out any other previous and existing patent, and all under the protection of the patent laws, provided only that he pays the fees; and more often than not patents are taken out, and the fees paid, in pure ignorance of what has been done before, and when the mistake is discovered the patent is abandoned, but the fees are not returned!

Another sore point is the question of fines if the patentee does not pay the renewal fees exactly to the day. (Fines are the meanest things ever invented.) Many inventors are their own patent agents, and often by inadventure, or inability, do not pay the fees the day they are due. Surely this could be met by a sworn declaration made within a reasonable time, and without the extra tax of a fine added to the already too heavy fees.

I hope you will take this subject up, and advocate the interest of the inventors and patentees, who form possibly the greater part of your subscribers. It requires an earnest effort to effect a reform.

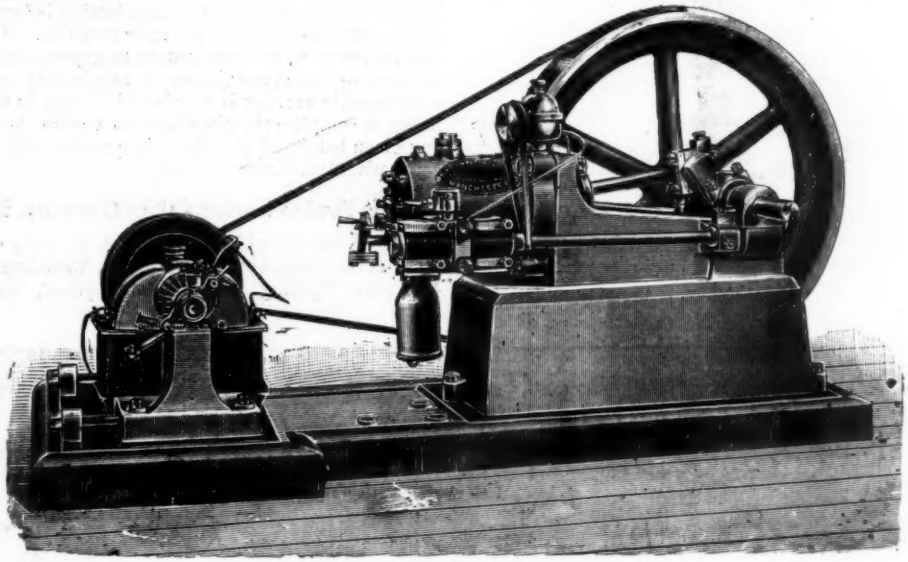
Henry F. Joel.

April 6th, 1892.

CRYSTAL PALACE ELECTRICAL EXHIBITION, 1892.

A good display of dynamos and gas engines is made by Roper's Electrical Engineering Company, of Trafalgar Works, Bradford, in the Machinery Room.

Conspicuous is a small 12-light dynamo fitted upon the same bedplate with a half-horse gas engine made by the National Gas Engine Company. This plant has been specially designed for lighting up small private houses, offices, &c. It requires little attention, and, we are informed, gives great satisfaction to users. The general view of the combination is given in the annexed illustration. The dynamo is a shunt wound one, running at 1,500 revs. per minute. The armature is of the drum type, and the commutator is built up of copper sections insulated with mica and having lugs cast on. These lugs are slotted out at the end, and into these slots the ends of the coils are soldered. We further noticed that between each coil a thin strip of mica was inserted the full length of the armature, thus reducing the chances of short circuiting. One peculiarity that we may mention is, that the slide rail bolts act in tension and not in compression, as is usually the case. The dynamo is of the vertical over-type, and the field magnet coils are readily detachable.



Small Gas Engine and Dynamo.

Amongst the other dynamos exhibited by this firm is a 20-light dynamo running at 1,450 revs. per minute. This machine is of the makers' C type, and is different in construction to their others, the magnet core being of wrought iron with cast iron pole pieces and bedplate. It is shunt wound, the armature being of the gramme type. The machine is very small for the number of lights driven from it and works very efficiently. Another 35-ampère, 65-volt dynamo with vertical magnets, is of similar design to the small dynamo. This machine is driven by a 2-H.P. improved "Otto" gas engine of the National Gas Engine Company's manufacture. A 200-ampère, 65-volt dynamo, is driven by a 10-H.P. Griffin gas engine; this runs at 750 revs. per minute without any perceptible sparking, and keeps wonderfully cool, while the compounding appears to be perfect. The dynamo was fitted with a drum armature, and we noticed that in places the soft iron core had been milled out and strips of celluvert had been tightly wedged in so as to prevent any dragging of the armature wires.

The flywheels fitted upon the dynamo for running with the gas engine were of unusual size and massiveness, the result being that the irregularities of the engine were quite overcome, and a perfectly steady light maintained.

This company also show several of their patent short arc lamps suspended by means of Nichol's patent arc lamp suspender, the patent of which they hold.

Jennings and Brewer's Reservoir Level Indicator.

The utility of apparatus which indicates in an engine-room or office the height of water in a distant reservoir is so obvious, that it is surprising that more of these are not in use. Practically the only agency which can be utilised to effect this purpose is that of electricity, and years ago the idea of so employing it was taken up by electrical instrument makers. As a matter of fact the problem to be solved has more of the mechanical than the electrical about it, and so we find one of the latest and best of these level indicators brought out by patentees who have endeavoured to correct certain faults of a mechanical nature which existed in the older forms. Messrs. Jennings and Brewer's apparatus, like those of other makers, consists of a cylinder sunk in the reservoir (*vide* fig. 1), inside which is a float, attached to a chain passing over a pulley, and counterpoised by a weight. The pulley keyed to a shaft, actuates the mechanism in the transmitter. For every inch, or other predetermined height, of rise or fall in the water level, a current is sent from the transmitter to the receiver and recorder, fig. 2, and is there indicated on a dial and registered (if required) on a diagram. The transmitter is very ingeniously constructed. Although the shaft revolves either backwards or forwards, as the float may be rising or falling, the transmitting mechanism which completes the circuit and sends a current through the line always runs in the same direction. The means taken to indicate rise or fall on the receiver is an electrical commutator in the transmitter, which is actuated by a double roller cam, and which, in the old telegraph parlance, sends either a copper or zinc current to line when the circuit has been completed, which is effected by another portion of the apparatus. Thus, suppose the float is rising a copper current will be sent, and if falling, a zinc. Contact is only made for a second or two, just sufficient to secure efficient working, so that the battery is worked most economically. In other words, the circuit is an open one, and the battery is only worked during the second or two when contact is made. For a line of four to five miles a battery of four to five No. 2 Leclanché cells is sufficient. As will be seen from the illustration, a single wire is used for the line, the transmitter and receiver being respectively connected to earth. The "receiver" is shown in fig. 2. The current enters at the right, traverses the relay there shown, energises one or other of the electro-magnet cores at the top, according to the direction of the current, pulls over the tongue in the centre, which then makes contact with one or other of the lower contacts. These are connected with a local battery of from seven to eight

Leclanchés, the current from which energises another set of electro-magnets fixed behind the dial. An armature connected with a train of wheels is so pivoted as to be under the influence of these electro-magnets, and is attracted by them one way or the other, according to the nature of the current transmitted. If the current is copper, the motion

Fig. 1.

of the train of wheels will be continuous in the direction of rise, and the dial hands will indicate the amount in inches (large hand), and feet (small hand). The same gearing also actuates a wedge-shaped disc at the top of the dial. When water is rising this disc shows white, when falling, red; so that an engine driver can tell at a glance how matters are going. The recorder portion of the apparatus is shown below the dial in the centre, the drum on which the diagram is pasted being driven by the clock at the left hand side, which is also useful as a time indicator. The pen, a special non-corrosive one, is fitted to an attachment which is driven by delicate chain gearing worked by a toothed wheel gearing with the train which moves the dial hands. The paper on the drum is ruled horizontally to indicate hours. At each predetermined variation of level (an inch in the case we have taken) the pen is drawn slightly to the right or left, according to whether it is recording a rise or fall, and so leaves a permanent record of the fact, and the time at which it occurred. The drum, clock, and relay are protected from dust, but everything is readily accessible when the front part of the case is unlocked and let down. We are assured by the patentees that the relay will stand a considerable amount of atmospheric electrical disturbance without getting out of order, and to preserve the coils of the electro-magnets from fusing, a lightning protector is always inserted in the circuit.

A modification of this apparatus has been adopted for recording the level of sewers. To a borough engineer, within whose district there is a low-lying portion liable to floods, the level recorder should be of great value, as it will indicate a rise in tenths of an inch, and even supposing it was beyond his power to prevent a flood, he would, at least, be able to warn inhabitants in the locality before the contents of the sewer appeared to tell their own tale. The utility of the indicator is, however, patent to anyone, and its application can be varied to suit almost any locality or liquid. If an automatic warning is required, it is easy to cause the dial hands to complete the circuit of an electric bell or bells at any given height of the liquid in question, this bell or bells being placed wherever required.

The Fowler-Waring Cables Company, Limited.

This company exhibits specimens of every class of electrical cable which they manufacture, including applications to electric lighting, transmission of power, telegraphy and telephony. A pyramid 26 feet high is formed of lengths which have been cut from representative cables manufactured at their North Woolwich Works. We shall deal in detail with this exhibit in a week or two.

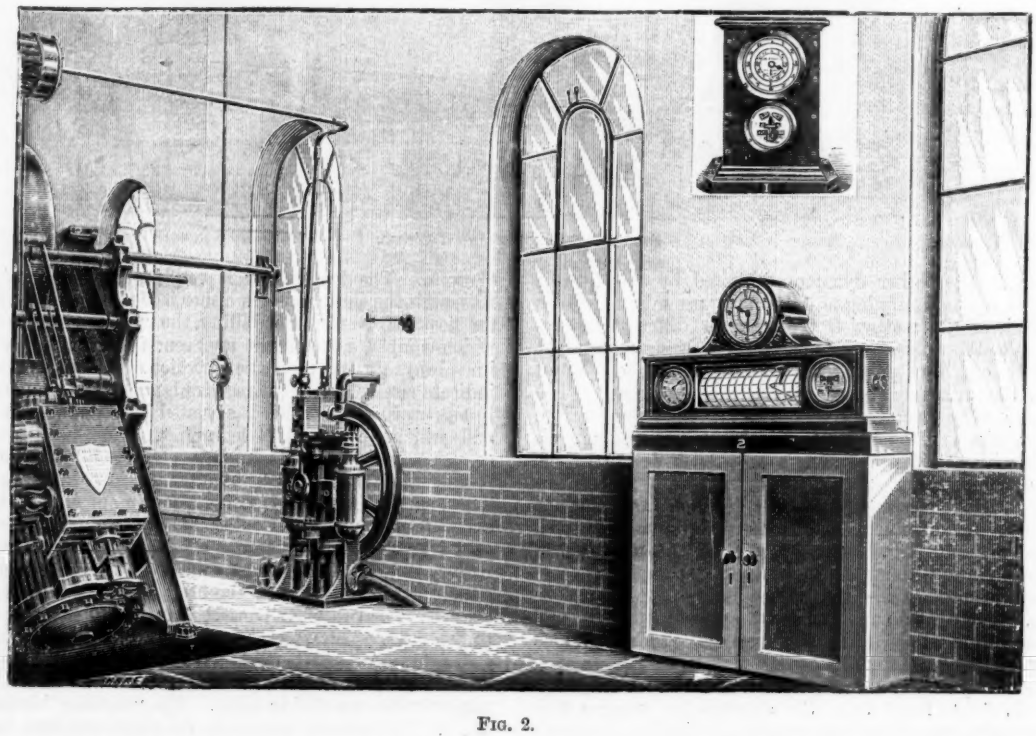


Fig. 2.